



Faculty of Health, Science and Technology
Environmental and Energy Systems

Syllabus

Advanced Computational Fluid Dynamics (CFD)

Course Code:	EMAD16
Course Title:	Advanced Computational Fluid Dynamics (CFD) <i>Avancerad Computational Fluid Dynamics (CFD)</i>
Credits:	7.5
Degree Level:	Master's level
Progressive Specialisation:	Second cycle, has only first-cycle course/s as entry requirements (A1N)

Major Field of Study:
KTA (Chemical Engineering)
MEI (Environmental and Energy Systems)

Course Approval

The syllabus was approved by the Faculty of Health, Science and Technology 2024-02-16, and is valid from the Autumn semester 2024 at Karlstad University.

Prerequisites

Fluid Mechanics, 7.5 ECTS credits, Heat and Mass Transfer, 7.5 ECTS credits, and registered for Applied CFD in Fluid Mechanics and Heat Transfer, 7.5 ECTS credits, plus upper secondary level Swedish 3 or Swedish as a second language 3 and English 6, or equivalent

Learning Outcomes

Upon completion of the course, students should be able to:

1. describe different turbulence models and use the right turbulence model for different fluid flow problems,
2. give an account of the purpose of the wall function in the turbulence model, and y^+ (dimensionless wall distance) estimation of the boundary layer in the turbulence model,
3. describe advantages and disadvantages of different types of grid (structured grid, unstructured grid, and hybrid grid), and select appropriate grid techniques for various

simulations,

4. conduct fluid flow and heat transfer simulations using commercial CFD software,
5. describe sources of error in the process from mathematical description to numerical solution of a problem related to fluid flow and heat transfer, and how those sources of error influence the results, and
6. present numerical methods and results of solving problems related to fluid flow and heat transfer through simulations, orally and in writing.

Content

The aim of the course is for students to acquire knowledge of Computational Fluid Dynamics (CFD), including methods used to analyse applied questions of fluid flow and heat transfer. In the course, students develop their ability to analyse and evaluate the results of CFD simulations.

The course covers the following:

- theory of turbulence modelling,
- commercial CFD software for simulating phenomena related to fluid flow and heat transfer,
- classification of the governing differential equations (continuity equation, momentum equation, energy equation) for CFD,
- turbulence models and wall function in turbulence models,
- different types of grid ((structured grid, unstructured grid, and hybrid grid) and grid refinement,
- grid-independent study and criteria for numerical convergence,
- validation of results from CFD simulation through experiments or theory,
- CFD for external/internal forced convection with different turbulence models,
- CFD for heat transfer, including conduction, convection, and radiation, and
- CFD for fluid flow in practice and heat transfer problems in technical applications.

Reading List

See separate document.

Examination

Assessment is based on individual hand-in assignments and a project presented orally.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades

One of the grades Distinction (VG), Pass (G), or Fail (U) is awarded in the examination of the course. For students in Engineering, one of the grades 5 (Pass with Distinction), 4 (Pass with Some Distinction), 3 (Pass), or U (Fail) is awarded in the examination of the course.

Quality Assurance

Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate

A course certificate will be provided upon request.

Additional information

The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.