Course syllabus

Avancerad CFD
Advanced CFD

VBRN85, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED BI/RH
Date of Decision: 2023-04-12

General Information

Elective for: BI4, RH4, BR4
Language of instruction: The course will be given in Swedish

Aim

The course is designed to provide knowledge of how the spread of fire and combustion gases is simulated using Computational Fluid Dynamics (CFD), vaious methods for modelling (LES, RANS), in e.g. fire safety design and fire investigations, as well as provide an understanding of the limitations of the numerical and physical models used, and an awareness of the most common sources of error. The course also aims to provide deeper knowledge, both theoretical and practical, about more advanced sub-models that are mainly used for research.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to describe the physical models used for conservation of mass, material, energy, and momentum.
- be able to describe various numerical methods for solving the equation sets.
- be able to identify the limitations and most common sources of error of the model components used.
- be able to apply different sub-models to practical problems as well as being able to discuss the results.

Competences and skills
For a passing grade the student must

- be able to perform advanced calculations of variuous applications using a selected CFD program.
- be able to assess calculated results against experimental data.
- be able to decide on how the uncertainty in a simulation can be estimated on the basis of assumptions included in the physical and numerical models used.
- be able to understand and use professional terminology within the field of fire evolution simulation using CFD.
- be able to report on, both orally and in writing, and discuss the implications of the executed simulation of the spread of combustion gases in association with fire safety design and fire investigations.
- be able to make use of material published in technical references and user manuals for advanced simulation programs for combustion gas spreading.
- be able toapply, with a certain degree of independence, newly-acquired knowledge to new fire safety design cases.

Judgement and approach
For a passing grade the student must

- demonstrate insight into the possibilities and limitations of fire safety simulation methods, as well as their role in advanced building technical project planning and in human responsibility for their use.
- demonstrate capability for identifying his/her own needs for further knowledge and for on-going improvement of his/her own competence in fire safety simulation.

Contents

- Introduction to CFD
- Time and length-scales in fires
- Turbulence models
- Numerical methods
- Large eddy simulation (LES)
- Combustion models
- Radiation models
- Soot models
- Heat transfer models
- Creation and processing of CFD models

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written individual examination and approved individual assignments. Presence at the seminars is mandatory.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0118. **Name:** Exam.
Credits: 3,5. **Grading scale:** TH. **Assessment:** Exam on the theoretical part of the course. **Contents:** Be able to describe the physical models used for conservation of mass, material, energy, and momentum. Be able to describe various numerical methods for solving the equation sets. Be able to identify the limitations and most common sources of error of the model components used. Be able to apply different sub-models to practical problems as well as being able to discuss the reults.
Code: 0218. **Name:** Assignments.
Credits: 4. **Grading scale:** UG. **Assessment:** Approved assignments and approved active participation in seminars. **Contents:** Assignments related to the lecturing material that is handed in individually and then discussed during seminars. The student should have worked with the given assignment and performed

simulations, generated results and present a discussion which relates to the presented theory, numerical errors, user errors, limitations of the model as well as common mistakes.

Admission

Admission requirements:

- VBRF10 Fire Dynamics

Assumed prior knowledge: FMA420 Linear Algebra or FMAB20 Linear Algebra, FAFA30 Physics: Electricity – Fluids, VBRF20 Fire Chemistry and Explosions, MMVA01 Thermodynamics and Fluid Mechanics, VBRN60 Fire Protection Systems
The number of participants is limited to: No
The course might be cancelled: If the number of applicants is less than 12.
The course overlaps following course/s: VBRF15, VBRN15, VBR200, VBRF16

Reading list

- Föreläsningsanteckningar.
- Manualer till olika datorprogram (FDS, Smokeview).
- G.Cox and S.Kumar: ”Modelling Enclosure Fires Using CFD”.
- • Tu, J. et al.: Computational fluid dynamics, A practical approach. Selected chapters.

Contact and other information

Course coordinator: Jonathan Wahlqvist, jonathan.wahlqvist@brand.lth.se