Course syllabus

Avancerade metoder inom numerisk strömningsmekanik och värmeöverföring
Advanced Methods within Numerical Fluid Mechanics and Heat Transfer

MVKN70, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED M
Date of Decision: 2023-04-11

General Information

Main field: Sustainable Energy Engineering.
Elective for: F5, F5-bem, M5-bem, Pi5-bem, MHET2
Language of instruction: The course will be given in English

Aim

The aim of the course is to provide basic knowledge about numerical methods that are rutinely used for simulating fluid flow and heat transfer. Knowledge on several ways of discretising such as finite differences and finite volumes is provided. Knowledge on how to numerically treat some flow and heat transfer phenomena such as shock waves, multiphase flow, thermal radiation and mass transfer is given. The course is aimed at providing capability to perform this kind of simulations. Also, to provide capability in analysing and assessing the results of such simulations. This knowledge should be sufficient in order to choose a proper solution method and assess the accuracy of the results for a given engineering problem.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to give an account for potentials and limitations of the methods covered in the course
- be able to give an account for different methods for numerically solving fluid mechanics problems and their applicability on different types of fluid flow
- be able to describe the most common discretisation methods and their advantages and disadvantages
- be able to describe the sources of errors in the process from mathematical description to numerical solution of fluid flow and heat transfer problems, and how these affect the results
- be able to describe how to treat certain phenomena numerically, e.g. shock waves, thermal radiation and chemical reactions
- be able to explain some, for the subject, important concepts

Competences and skills
For a passing grade the student must

- be able to analyse fluid flow or heat transfer case and suggest a solution strategy of it concerning equations, possible simplifications, choice of numerical method and turbulence model and to compare to alternative methods and models
- be able to critically review and assess the accuracy and plausibility of results of fluid flow simulations from given criteria

Judgement and approach
For a passing grade the student must

- be able to take active part in discussions on for the subject relevant problems
- be able to present, orally and in writing, a technical report containing analyses and choice of numerical solution method and turbulence model

Contents

The course treats methods for numerical simulation of fluid dynamics and heat transfer problems, both incompressible and compressible. Discretiation using finite differences, finite volumes and to some extent finite elemets. Both compressible and incompressible flows are treated. Methods for handling multiphase flow and heat and mass transfer are included. Also, methods for chemical reactions (e.g. combustion are treated. Methods for improving computational efficiency (e.g. multi grid methods) are alos included.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Examiantion is both individual and based on group work. The mandatory homeworks and computer laboratory exercises are reported individually in writing. Attendance at the computer laboratory exercises is mandatory. The project work is reported in groups both in writing and orally at a seminar where all groups members must take active participation. The examination also includes a written theory test. To pass the course all mandatory parts, i.e. homeworks, laboratory exercises, project work and the theory test must be approved. The grade is set based on the project work report and the theory test.

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.

Admission

Admission requirements:

- FMA430 Calculus in Several Variables or FMAB30 Calculus in Several Variables
- FMA420 Linear Algebra or FMAB20 Linear Algebra
- KETF01 Transport Phenomena, Basic Course or MMV211 Fluid Mechanics or MMVF01 Thermodynamics and Fluid Mechanics or MMVF10 Fluid Mechanics or MMVF15 Fluid Mechanics or MMVN10 Fluid Mechanics

Assumed prior knowledge: MMVN05 Numerical Fluid Dynamics and Heat Transfer or MMV042 Numerical Heat Transfer or MVKN45 Applied Computational Fluid Mechanics.
The number of participants is limited to: No
The course overlaps following course/s: MVKN45, MMV042

Reading list

- Material handed out during the course. As complementary material you can use any book on CFD. If you do not have one, the book by Dale Anderson, John C. Tannehill, Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, 3rd ed., CRC Press, ISBN 9781591690375, 2012, is a good choice.

Contact and other information

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