LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Numerisk strömningsmekanik och värmeöverföring
Numerical Fluid Dynamics and Heat Transfer

MMVN05, 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

Elective Compulsory for: MHET1
Elective for: F4, F4-bem, K4-p, M4-bem, Pi4-bem, W4-p
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. The main emphasis is on incompressible flow and convective heat transfer. Furthermore, knowledge on the most common turbulence models and how these affect the solution is provided. The course is aimed at providing capability to perform this kind of simulations. Also, to provide capability in analysing and assesing the results of such simulations. This knowledge should be sufficient in order to chose a proper solution methos and asses 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 account for potentials and limitations of the methods covered in the course.
- be able to account for the most common RANS based turbulence models and how these may affect the numerical solution of fluid flow
- be able to account for the process from mathematical description to numerical solution

of fluid flow and heat transfer problems, and for the demands on the system for it to be soluble.
- 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 account for methods for treating convection-diffusion terms, and algorithms for pressure-velocity coupling (e.g. SIMPLE, SIMPLEC, SIMPLEX, PISO etc)
- Be able to explain some, for the subject, important concepts

Competences and skills
For a passing grade the student must

- be able to perform simulations in some commercial CFD software
- 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 asses 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 suject relevant problems
- be able to present, orally and in writing, a technical report containing analyses and choice of numerical solution metod and turbulence model

Contents

The course includes methods for the numerical solution of engeering fluid dynamics and heat transfer problems. Handling of convection-diffusion problems is treated. The concept of numerical diffusion is introduced. Algorithms for pressure-velocity coupling are presented (e.g. SIMPLE, SIMPLEC, SIMPLEX, PISO etc). In the course discretisation using finite volume techniques and how these affect accuracy and stability is discussed. Several types of computational meshes and how these are generated and how these affect the solution are discussed. Aslo included are the most common RANS based turbulence models.

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 FMA435 Calculus in Several Variables or FMAB30 Calculus in Several Variables or FMAB35 Calculus in Several Variables
- KETF01 Transport Phenomena, Basic Course or MMVF01 Thermodynamics and Fluid Mechanics or MMVF10 Fluid Mechanics or MMVF15 Fluid Mechanics or MMVN10 Fluid Mechanics
- FMA420 Linear Algebra or FMAA20 Linear Algebra with Introduction to Computer Tools or FMAB20 Linear Algebra

Assumed prior knowledge: MMVF05 Heat Transfer
The number of participants is limited to: No
The course overlaps following course/s: MVKN45, MMV042

Reading list

- H K Versteeg & M W Malalasekera: An Introduction to Computational Fluid Dynamics-The Finite Volume Method 2nd ed. Pearson Education Limited, 2007.

Contact and other information

Course coordinator: Hesameddin Fatehi, hesameddin.fatehi@energy.lth.se
Examinator: Hesameddin Fatehi, hesameddin.fatehi@energy.lth.se
Course coordinator: Christer Fureby, christer.fureby@energy.lth.se
Course homepage: https://www.energy.lth.se/english/education/