Course syllabus

Turbulens - teori och modellering
Turbulence - Theory and Modelling

MVKN90, 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 for: F5, F5-bem, M4-bem, Pi4-bem, MHET2
Language of instruction: The course will be given in English

Aim

The aim of this course is to provide basic theoretical knowledge on turbulence as well as the design of turbulence models and their applicability. Furthermore, the intention is to provide skills in the analysis of turbulent flows. This knowledge should be sufficient to understand the background of turbulence models and the ability to chose an appropriate turbulence model for a given flow case.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to describe the physical mechanisms during the transition from laminar to turbulent flow for a simple flow case
- be able to explain Kolmogorov's theory, the underlying assumptions and the theory's validity
- be able to account for the different basic types of turbulence models with regard to physical background, assumptions and applicability to different flow cases
- be able to judge from a phenomenological perspective whether a flow is turbulent

- be able to explain some important and basic concepts for the subject
- be able to describe the nature of turbulence in different types of flow with respect to the properties and development of the turbulence, and explain how the difference between these types of flow is reflected in the modeling

Competences and skills
For a passing grade the student must

- be able to analyse a flow case and suggest a method for numerical simulation with respect to governing equations, possible simplifications and choice of turbulence model, and also to compare with alternative methods.
- be able to scrutinise and from given criteria estimate the credibility of results from turbulent flow simulations

Judgement and approach
For a passing grade the student must

- be able to actively participate in discussion of problems relevant for the subject
- be able to present, both orally and in writing, a technical report containing analyses and choice of turbulence model

Contents

The course contains the basic theory for turbulent flows, the transition from laminar to turbulent flows and the physical basis for different types of turbulence models. The turbulence theory part contains statistical and phenomenological description of turbulence Kolmogorov's hypotheses, and also wall bounded and free shear flows. Homogeneous and isotropic turbulence is discussed as well as anisotropy in different types of flow. The modelling part contains the most common types of turbulence models, i.e the ones based on the Reynolds averaged equations and Large Eddy Simulation. The physical background and effects of different models are discussed. The mathematical description is also treated, averaging of the governing equations, and derivation of the extra equations needed.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Examination is individual as well as based on group work. The compulsory home works and laboratory exercises are reported in writing, individually. The project assignment is reported group-wise both in writing and orally at a seminar, where all group members shall participate actively. To get a passing grade (grade 3) all compulsory parts, i.e. home works, laboratory exercises and the project assignment must be approved. A higher grade of 4 is set based on homeworks and the project report. A full grade 5 is given based on a voluntary oral exam

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:

- KETF01 Transport Phenomena, Basic Course or MMVF01 Thermodynamics and Fluid Mechanics or MMVF10 Fluid Mechanics or MMVF15 Fluid Mechanics
- FMA430 Calculus in Several Variables or FMA435 Calculus in Several Variables or FMAB30 Calculus in Several Variables or FMAB35 Calculus in Several Variables
- FMA420 Linear Algebra or FMAB20 Linear Algebra

The number of participants is limited to: No

Reading list

- Pope, S. B.: Turbulent Flows. Cambridge University Press , 2003, ISBN: 0-521-59886-9.

Contact and other information

Course coordinator: Rixin Yu, rixin.yu@energy.lth.se
Examinator: Rixin Yu, rixin.yu@energy.lth.se
Course homepage: https://www.energy.lth.se/english/education/
Further information: The course is based on lectures, exercises, laboratory exercises, home work and group work in the form of a smaller project assignment. The course will be given in English.