Course syllabus

Flerfasströmning - teori, modellering och numeriska metoder Multiphase Flow - Theory, Modelling and Numerical Methods

MVKP20, 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, M4, MHET2
Language of instruction: The course will be given in English

Aim

The aim of this course is to provide an introduction to multiphase flows concerning basic theoretical knowledge and the design of multiphase models and their applicability. Also, to provide knowledge on the numerical methods used for simulating flows with more than one phase. Furthermore, the intention is to provide skills in the analysis of multiphase flows. This knowledge should be sufficient to understand the background of multiphase models and the ability to choose an appropriate model for a given flow case.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

be able to describe different types of multiphase flow from a physical perspective
be able to describe interaction mechanisms between the phases
be able to explain some of the important and basic terms of the subject
be able to describe how the character of the multiphase flow is reflected in the modelling and in the choice of numerical method

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 multiphase model, and also to compare with alternative methods.
be able to scrutinise and from given criteria estimate the credibility of results from multiphase 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 of a multiphase flow situation, concerning choice of models and numerical methods, as well as simulation results

Contents

The course contains the basic theory for multiphase flows, how such flows may be classified and how that in turn is reflected in the modelling. The theoretical part contains description of the various kinds of multiphase flows occurring in industrial applications, such as sprays, particle clouds, free surface flows etc. Forces on and interaction among particles, bubbles and droplets are discussed as well as the influence of surface tension and virtual mass. The modelling part contains the most common types of multiphase flow models, including models for dispersed flow (e.g. Lagrangian particle tracking, and discrete element modelling) as well as Eulerian continuum models and interface models. The physical background, applicability and effects of the different models are discussed. The mathematical description is also treated, averaging of the governing equations, and derivation of the extra equations needed. The numerical methods ae discussed with emphasis on what is needed beyond the methods for single phase flows. Computer laboratory exercises and project work will be performed in commercial or open CFD software.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Assessment is individual as well as based on group work. The mandatory 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. The examination also includes a written theory test. To pass all mandatory parts must be approved, i.e. home works, laboratory reports, project work and theory test. The grade is based on the theory test and the project report.

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
- FMA420 Linear Algebra or FMAB20 Linear Algebra
- KETF01 Transport Phenomena, Basic Course or MMVF01 Thermodynamics and Fluid Mechanics or MMVF10 Fluid Mechanics or MMVF15 Fluid

Mechanics or MMVN10 Fluid Mechanics or VVRF10 Fluid Mechanics or VVRN35 Hydromechanics

The number of participants is limited to: No

Reading list

- Tu, J., Yeoh, G.H.: Computational techniques for multiphase flows. Butterworth-Heinemann, 2019, ISBN: 9780081024539.
- Yadigaroglu, G. Hewitt, G.F. (eds): Introduction to multiphase flow basic concepts, Applications and modelling. Springer, 2018, ISBN: 9783319587172.

Contact and other information

Course coordinator: Johan Revstedt, johan.revstedt@energy.lth.se
Examinator: Christer Fureby, christer.fureby@energy.lth.se
Course coordinator: Christer Fureby, christer.fureby@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