

Computational Fluid Dynamics (E045240)

Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

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|---|--|--------------------|------------------------------------|--------|
| Course size | <i>(nominal values; actual values may depend on programme)</i> | | | |
| Credits 6.0 | Study time 180 h | Contact hrs | 60.0 h | |
| Course offerings and teaching methods in academic year 2022-2023 | | | | |
| A (semester 2) | English | Gent | project | 5.0 h |
| | | | lecture | 30.0 h |
| | | | seminar: practical PC room classes | 25.0 h |
| B (semester 2) | Dutch | | project | 5.0 h |
| | | | guided self-study | 30.0 h |
| | | | seminar: practical PC room classes | 25.0 h |
| C (semester 2) | English | | project | 5.0 h |
| | | | lecture | 30.0 h |
| | | | seminar: practical PC room classes | 25.0 h |

Lecturers in academic year 2022-2023

Degroote, Joris TW08 lecturer-in-charge

| Offered in the following programmes in 2022-2023 | crdts | offering |
|--|-------|----------|
| Bridging Programme Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering) | 6 | A |
| Courses on Offer by the Doctoral Schools Ghent University | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation) | 6 | B |
| Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering) | 6 | B |
| Master of Science in Electromechanical Engineering (main subject Maritime Engineering) | 6 | B |
| Master of Science in Electromechanical Engineering (main subject Mechanical Construction) | 6 | B |
| Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering) | 6 | A |
| Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering) | 6 | B |
| Master of Science in Electromechanical Engineering Technology | 4 | C |
| Master of Science in Chemical Engineering | 6 | A, B |
| European Master of Science in Nuclear Fusion and Engineering Physics | 6 | A |
| Master of Science in Chemical Engineering | 6 | A, B |

Teaching languages

Dutch, English

Keywords

Fluid Mechanics, Computational Fluid Dynamics, CFD

Position of the course

An introduction to the equations and computational techniques in fluid mechanics.
The full version of this course is 6 ECTS, but it is also offered as a partim version of 4 ECTS,

as an elective course in the programmes Master of Science in Electrical Engineering Technology and Master of Science in Electromechanical Engineering Technology (course offering C). In this partim version we focus on the practical use of computational techniques in fluid mechanics.

Contents

Theoretical background (only for the course offerings of 6 ECTS; voluntary participation in the theory lectures without evaluation in the course offering of 4 ECTS):

- Flow equations: conservation equations and state equations, mathematical character of flow equations
- Turbulence models for viscous flows: transition and turbulence, Reynolds averaging, turbulent viscosity, two-equation eddy viscosity models, RSM, LES and DNS
- Grid generation and spatial discretisation: structured and unstructured grids, cell-centred and vertex-based finite volume methods
- Finite volume methods for diffusion and convection-diffusion: steady state diffusion, steady state convection-diffusion, central and upwind discretisations
- Higher order discretisation of convection-diffusion: quadratic upwind discretisation, non-linear upwind discretisation: TVD-schemes
- Pressure-velocity coupling: pressure oscillations, momentum interpolation, pressure correction algorithms
- Solution methods for systems of equations: direct methods, iterative methods, multigrid formulation
- Unsteady flows: implicit and explicit time stepping schemes
- Heat transfer, rotating domains, multiphase flow, fluid-structure interaction

Exercises using CFD tools (for all course offerings):

- Calculate mixing of a cold and hot flow in a tube
- Compare discretisation schemes
- Calculate the wake of a cylinder
- Compare turbulence models for a dump diffusion
- Calculate subsonic, transsonic and supersonic flow around an airfoil
- Compare techniques for rotating machines
- Calculate how a valve opens

Initial competences

Transport phenomena

Final competences

- 1 Describe selected techniques in computational fluid dynamics (applicable for the course of 6 ECTS)
- 2 Select appropriate numerical techniques and settings for a flow problem (applicable for the full version of 6 ECTS and the partim version of 4 ECTS)

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Guided self-study, lecture, project, seminar: practical PC room classes

Extra information on the teaching methods

- Course of 6 ECTS: lecture, project, seminar: practical PC room classes
- Partim version of 4 ECTS: lecture (recommended), project, seminar: practical PC room classes

Learning materials and price

- Slides and book
- Tutorials with Fluent and OpenFOAM

References

- An Introduction to Computational Fluid Dynamics: The Finite Volume Method (2nd edition), H. Versteeg and W. Malalasekera, Pearson Prentice Hall, 2007.

Course content-related study coaching

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Written examination with open questions

Examination methods in case of periodic evaluation during the second examination period

Written examination with open questions

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible

Extra information on the examination methods

Version of 6 ECTS:

- Periodic (end-of-term) evaluation: written examination with closed book. Second evaluation: written examination with closed book.
- Permanent evaluation: assessment of project report. Frequency: 1 report.

For the partim version of 4 ECTS:

- Permanent evaluation: assessment of project report. Frequency: 1 report.

Calculation of the examination mark

Version of 6 ECTS:

- Periodic (end-of-term) evaluation 50%, permanent evaluation 50%
- Special condition: If the student scores less than 8/20 for at least one component of the assessment, a pass mark for the course unit in question is not possible. If the final mark does turn out to be a 10/20 or more, this will be reduced to the highest non-deliberative mark, i.e. 7/20.