

Computational Fluid Dynamics (E045240)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0

Study time 180 h

Course offerings and teaching methods in academic year 2026-2027

A (semester 2)	English	Gent	lecture seminar
B (semester 2)	Dutch	Gent	
C (semester 2)	English	Gent	

Lecturers in academic year 2026-2027

Degroote, Joris	TW08	lecturer-in-charge
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Offered in the following programmes in 2026-2027

	crdts	offering
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	B
Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering)	6	A

Teaching languages

English, Dutch

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

Seminar, Lecture, Independent work

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

Study material

Type: Handbook

Name: An Introduction to Computational Fluid Dynamics: The Finite Volume Method
 Indicative price: € 75
 Optional: yes
 Language : English
 Available in the Library : Yes

Type: Slides

Name: Slides
 Indicative price: Free or paid by faculty
 Optional: no
 Language : English
 Available on Ufora : Yes

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

Assessment moments

end-of-term and continuous assessment

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

Written assessment with open-ended questions

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

Written assessment with open-ended questions

Examination methods in case of permanent assessment

Assignment

Possibilities of retake in case of permanent assessment

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.