GHENT UNIVERSITY

# Course Specifications

From the academic year 2024-2025 up to and including the academic year

## 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 2025-2026**

| | | | |
|---|---|---|---|
| A (semester 2) | English | Gent | lecture<br>seminar |
| B (semester 2) | Dutch | Gent | |
| C (semester 2) | English | Gent | lecture<br>seminar |

**Lecturers in academic year 2025-2026**

| | | |
|---|---|---|
| Degroote, Joris | TW08 | lecturer-in-charge |

| **Offered in the following programmes in 2025-2026** | **crdts** | **offering** |
|---|---|---|
| Bridging Programme Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering) | 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 | B |
| Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering) | 6 | A |
| European Master of Science in Nuclear Fusion and Engineering Physics | 6 | A |
| Master of Science in Chemical Engineering | 6 | A, B |
| Master of Science in Chemical Engineering | 6 | A |
| Master of Science in Electromechanical Engineering Technology | 4 | C |

**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. Malalasekra, 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.