

## Modelling and Simulation with Partial Differential Equations in Practice (I002157)

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

Credits 5.0 Study time 135 h Contact hrs 60.0 h

Course offerings and teaching methods in academic year 2017-2018

|                |         |                    |        |
|----------------|---------|--------------------|--------|
| A (semester 1) | English | seminar: practical | 17.5 h |
|                |         | group work         | 17.5 h |
|                |         | lecture            | 25.0 h |

Lecturers in academic year 2017-2018

|                |      |                    |
|----------------|------|--------------------|
| Nopens, Ingmar | LA26 | lecturer-in-charge |
| Baetens, Jan   | LA26 | co-lecturer        |

Offered in the following programmes in 2017-2018

|  | crdts | offering |
|--|-------|----------|
| <a href="#">Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology</a> | 5     | A        |
| <a href="#">Master of Science in Bioscience Engineering: Food Science and Nutrition</a>          | 5     | A        |
| <a href="#">Master of Science in Bioscience Engineering: Environmental Technology</a>            | 5     | A        |

Teaching languages

English

Keywords

Partial differential equations; Computational Fluid Dynamics (CFD); numerical techniques

Position of the course

**This course constitutes a continuation of the Bachelor** course Modelling and Simulation of Biosystems, which is restricted to models based upon ordinary differential equations. Since most models for describing real-world phenomena are based upon partial differential equations, this course provides the insights and tools that are needed for developing and understanding such models.

Contents

- I. Introduction
  - Basic math of partial differential equations (PDEs)
  - Partial differential equations frequently used for describing environmental and biochemical industrial processes
    - o Reaction-diffusion equation
    - o Convection-diffusion equation
    - o Wave equation
    - o Navier-Stokes equation
- II. Simulating PDE-based models
  - Finite difference method
    - o Methods for elliptic equations
    - o Methods for parabolic equations
    - o Methods for hyperbolic equations
  - Finite element method
    - o Weak formulation
    - o Meshing methods
    - o Weighted residuals and Galerkin method
  - Finite volume method

### III. Computational Fluid Dynamics (CFD)

- Formulation
  - o Navier-Stokes equations
  - o Turbulence modeling
  - o Species equations
- Incorporating kinetics into CFD

#### Initial competences

Modelling and Simulation 2: Partial Differential Equations in Practice builds on certain learning outcomes of course units 'Mathematics3: Differential Equations', 'Physics 4: Physical Transport Phenomena' and Modelling and Simulation of Biosystems ; or the learning outcomes have been achieved differently.

#### Final competences

#### Conditions for credit contract

Access to this course unit via a credit contract is unrestricted: the student takes into consideration the conditions mentioned in 'Starting Competences'

#### Conditions for exam contract

This course unit cannot be taken via an exam contract

#### Teaching methods

Group work, lecture, seminar: practical PC room classes

#### Learning materials and price

Syllabus (electronic)

#### References

Kwong, Y. W. and Bang, H. (1996). The finite element method using MATLAB. CRC Press. Ramkrishna D. (2000). Population balances: theory and applications to particulate systems in engineering. Academic Press.

#### Course content-related study coaching

Study coaching is offered before and after each of the theory lectures and computer laboratories or after appointment

#### Evaluation methods

end-of-term evaluation

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

Open book examination, oral examination, report

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

Open book examination, oral examination, report

#### Examination methods in case of permanent evaluation

#### Possibilities of retake in case of permanent evaluation

not applicable

#### Extra information on the examination methods

The student defends his/her report of a simulation exercise

#### Calculation of the examination mark

Students who eschew period aligned and/or non-period aligned evaluations for this course unit may be failed by the examiner