GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2025-2026

Modelling and Simulation (C003786)

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 1)	Dutch	Gent	seminar
			lecture

Lecturers in academic year 2025-2026

Van Daele, Marnix	WE02	lecturer-in-charge

Offered in the following programmes in 2025-2026	**crdts**	**offering**
Bachelor of Science in Computer Science	6	A

Teaching languages

Dutch

Keywords

Ordinary and partial differential equations, Fourier analysis, random numbers, multidimensional integrals

Position of the course

We start with several mathematical topics from the field of analysis and algebra. This will give the student access to some important subfields or application fields of informatics such as statistical informatics, applications in scientific computing, electronic aspects of information processing, algorithms for image compression and image processing, ... Some of the subjects will be treated both analytically as well as numerically.

Contents

1. Differential equations

ordinary differential equations:

- analytical solution of some specific classes
- numerical solution with special attention for
  - linear multistep methods, Runge-Kutta methods, PC-pairs, ...
  - accuracy and stability
- initial value problems and boundary value problems
- eigenvalueproblems

partial differential equations

- classification into equations of parabolic, hyperbolic and elliptic type and some specific solution techniques
- some numerical solution techniques (semi-discretisation and complete discretisation)

2. Fourier series and the Fourier transform

- analytically : Euler's formula for Fourier series of a periodic function
- numerically: trigonometric interpolation leads to DFT; FFT: a special implementation of the DFT; from DFT to DCT; wavelets

3. Random numbers and simulation

4. Computation of multidimensional integrals

- theoretical aspects such as coordinate transformations
- numerical aspects (quadrature formulae, Monte-Carlo methods, ...)

Initial competences

- The students have obtained the final competences of the courses Discrete Mathematics, Calculus, Linear algebra and geometry and Scientific computing.

Final competences

1 Determine the Fourier series expansion of a periodic function and know to what it converges in every point. Compute and apply Fourier transforms. Have insight in the DFT and FFT algorithms. Understand the relation between DFT and FFT.
2 Solve a number of special types of ordinary differential equations. Know the structure of the solution space of a linear differential equation.
Be able to use numerical techniques for solving ordinary differential equations in initial value problems and in boundary value problems.
3 Solve a partial differential equation either by separation of variables or by using the fundamental solutions of d'Alembert.
Be able to apply different types of numerical methods, based on full discretisation or based on semi-discretisation.
4 Compute multidimensional integrals analytically as well as numerically.
5 Understand how random number generators work and be able to apply them.

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

Extra information on the teaching methods

Exercises: both paper and pencil exercises and exercises with computer.

Study material

Type: Handbook

Name: Scientific computing: an introductory survey
Indicative price: € 60
Optional: yes
Language : English
Author : Michael Heath
ISBN : 978-1-61197-557-4
Number of Pages : 576
Oldest Usable Edition : 2001
Online Available : Yes
Available in the Library : No
Available through Student Association : No
Usability and Lifetime within the Course Unit : regularly
Usability and Lifetime within the Study Programme : one-time
Usability and Lifetime after the Study Programme : not
Additional information: The slides should suffice to follow this course, but for certain chapters the book can give extra information for the interested student.

Type: Slides

Name: Slides
Indicative price: Free or paid by faculty
Optional: no
Language : Dutch
Number of Slides : 500
Oldest Usable Edition : 2023
Available on Ufora : Yes
Online Available : No
Available in the Library : No
Available through Student Association : No

Type: Software

Name: Edcuational modules
Indicative price: Free or paid by faculty
Optional: no
Available on Athena : No
Online Available : Yes
Available in the Library : No
Available through Student Association : No

Usability and Lifetime within the Course Unit : regularly
Usability and Lifetime within the Study Programme : one-time
Usability and Lifetime after the Study Programme : not
Additional information: The modules follow the book and the slides.

References

M. Heath, Scientific computing, an introductory survey, second Edition, Mc Graw Hill, 2002, ISBN 0-07-239910-4

Course content-related study coaching

Individual contact with the lecturer, use of the electronic teaching environment Ufora.

Assessment moments

end-of-term and continuous assessment

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

Written assessment

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

Written assessment

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

Examinations on theory and exercises are in written form; in the exercises part a computer can be used. There is a closed-book part (mainly theory) and an open-book part (exercises).

Calculation of the examination mark

First chance period:

score= 0.4 * score_theory + 0.4 * score_exercises + 0.2 * score_project
whereby score_theory, score_exercises and score_project belong to [0,20]

Second chance period: the project may be returned to improve the score for that component. This score (in [0,20]) is score_project_2.

score= 0.4 * score_theory_2 + 0.4 * score_exercises_2 + 0.2 * score_project
whereby score_theory_2 and score_exercises_2 are the scores (in [0,20]) obtained in the second chance period.