GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Numerical Analysis (C003608)

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

Credits 6.0 **Study time 165 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	Dutch	Gent	lecture seminar

Lecturers in academic year 2024-2025

Köllermeier, Julian	WE02	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Bachelor of Science in Mathematics	6	A

Teaching languages

Dutch

Keywords

Numerical solutions, constructive methods, algorithms, stability, convergence

Position of the course

Numerical mathematics belongs to the key domains of mathematics, and is one of the basic subjects for applied mathematics. The student gets acquainted with a specific way of thinking, learns how to tackle mathematical problems numerically, and is introduced to appropriate software. Particular objectives are:

- Convince the students of the necessity of the numerical solution of certain classical problems appearing in mathematical applications.
- Convince students that, in order to solve a mathematical problem on a computer, often new techniques and algorithms are necessary.
- Introduce students to constructive methods for the numerical solution of such problems, and to the study of related subjects such as stability and convergence.
- Ensure that students have proper insight in the underlying mathematical objects.
- Introduce students to classical numerical algorithms, by own implementations and by showing them the way to professional mathematical software.

Contents

Introductory concepts : floating point arithmetic, error theory, additional mathematical concepts. Linear systems and matrix decomposition (LU and Householder QR decomposition). Iterative methods for equations and systems (convergence, Newton-Raphson, secant method, Gauss-Jacobi, Gauss-Seidel and SOR). Eigenvalues and eigenvectors (Jacobi method, tridiagonal systems, power method). Polynomial interpolation (Lagrange and Newton interpolation formulas, Hermite Interpolation, application to numerical differentiation and Richardson extrapolation). Approximation (discrete and continuous least squares approximation, orthogonal polynomials, Chebyshev polynomials and error reduction). Numerical integration (Newton-Cotes, Peano error representation, Romberg integration, Gaussian quadrature). Numerical methods for first order ordinary differential equations (Euler, Taylor, Runge-Kutta, Adams and Milne formulas). Finite difference methods for boundary-value and eigenvalue problems.

Initial competences

Final competences of the courses Analysis I and Analysis II.

Final competences

1 The student knows the classical methods of numerical mathematics, knows

when they can be applied, and understands their convergence behaviour and stability.
2 He/she has proper insight in the new underlying mathematical concepts of numerical methods.
3 He/she can use these insights for the solutions of new problems, knows his/her way to professional software, and can use ICT.
4 The student can perform project work, related to the contents of the course, and present the results in a comprehensible way.

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

Theory: lectures. Exercises and programming classes: individual coaching. Use of Ufora for the distribution of material

Study material

Type: Syllabus

Name: Syllabus'
Indicative price: € 10
Optional: no
Additional information: A syllabus is available. Demonstrations with applets are also available. Extra exercises, tests and exam questions are being distributed.

References

G. Hämmerlin & K. Hoffmann: Numerical Mathematics, Springer-Verlag (1991). ISBN 0-387-97494-6.
R. Kress: Numerical analysis, Springer-Verlag (1998). ISBN 0-387-98408-9.

Course content-related study coaching

During the lectures, the necessary coaching is given for the understanding of the material. However, the lecturer is always available for additional explanations. During exercise classes and PC-sessions specific training is given by an assistant in order to develop the attitudes and skills specific for this course. The demonstrations showed during lectures and solutions to PC-exercices are available on Ufora. During the semester, a model examination is organised: this helps the student to assess the requirements of the final examination and thus to better prepare himself/herself.

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 not possible

Extra information on the examination methods

During the *theory examination* the reproduction of lecture material is not requested, but by short directed questions the understanding of derivations and arguments is assessed. Also the vertical understanding (interconnections and relations between various methods) is being tested. The *exercise examination* evaluates whether the student can apply the new material, and during the test students can make use of their lecture notes.
For the *project work*, the student makes in a number of tasks during the first half of

the semester.

Calculation of the examination mark

In the theory test it is examined whether the student has acquired sufficient insight in and understanding of the basic notions of numerical analysis. In the exercise test it is examined whether the student can apply his/her insights to problems.
The final examination counts for 85% of the marks, and the project work for 15%.