GHENT UNIVERSITY

Course Specifications

From the academic year 2017-2018 up to and including the

Advanced Numerical Methods (C004011)

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

Credits	6.0	Study time	180 h
Contact hrs	45.0 h		

Course offerings and teaching methods in academic year 2018-2019

A (semester 1)	Dutch	lecture	30.0 h
		seminar: coached exercises	15.0 h
		seminar: practical PC room classes	15.0 h

Lecturers in academic year 2018-2019

Van Daele, Marnix	WE02	lecturer-in-charge

Offered in the following programmes in 2018-2019	crdts	offering
Master of Science in Computer Science	6	A
Master of Science in Mathematics	6	A

Teaching languages

Dutch

Keywords

Numerical methods, linear multistep methods, Runge-Kutta methods, stability, accuracy
Ordinary differential equations; partial differential equations

Position of the course

Differential equations appear in all kinds of applications. Their solutions however can rarely be written down in a closed form and so a numerical, approximative procedure is needed. The aim of this course is

- to make students acquainted with the most important classes of numerical methods for solving ordinary and partial differential equations.
- to teach students to use modern computer tools for solving differential equations.

Contents

1 Overview of different kinds of problems: initial value problems, boundary value problems, eigenvalue problems, differential algebraic problems, integro-differential problems, delay differential equations, stiffness.
2 Overview of the most important properties of numerical methods for ordinary differential equations: zero-stability and consistency, order, implicit and explicit methods, stability.
3 Multistep methods: construction (Adams type and BDF type), order, stability, error estimation, PC-pairs.
4 Runge-Kutta-methods: construction using the Butcher theory, order, stability, error estimation, collocation methods.
5 Aspects of numerical geometric integration: symplectic methods.
6 Partial differential equations : treatment of some standard equations of parabolic, hyperbolic and elliptic kind.

Initial competences

In the second year the student have studied a first course in het field of numerical analysis. The last chapter of that course gives a brief introduction to this course. Also, the students are acquainted with analysis and algebra and on the other hand, the students also have the skills to implement algorithms on a computer.

Final competences

1 The students have learnt how to become intelligent users of state-of-the-art software

for solving differential equations: this means that the students have insight into the characteristics of the most important classes of numerical methods and they understand how and when to apply these methods.
2 The students understand the mathematical ideas underlying the numerical methods.
3 Students know where to find professional software and how to deal with it.

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

Lecture, seminar: coached exercises, seminar: practical PC room classes

Extra information on the teaching methods

Also Minerva (http://Minerva.UGent.be) and ILONA (http://www.ilona.ugent.be/)) will be used.
On request the learning material can be provided in English.

Learning materials and price

A syllabus, with exercises and their solutions in printed or electronic form are available.
Also Matlab-files, Maple-worksheets and Java-applets are used.
All the material is available via Minerva.
Price: approximately 10 euro.

References

E. Hairer, S. Norsett, G. Wanner, Solving ordinary differential equations I, Nonstiff problems, Springer, 2nd Edition, 1993.
E. Hairer, S. Norsett, Solving ordinary differential equations II, Stiff and Differential-Algebraic Problems, Springer, 2nd Edition, 1996.
K.W. Morton and D.F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press, 1994

Course content-related study coaching

The students can make an appointment with the lecturer to have some extra individual coaching. Interactive coaching via Minerva: Forum (students among themselves, students-lecturer).

Evaluation methods

end-of-term evaluation and continuous assessment

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

Written examination with open questions, open book examination

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

Written examination with open questions, oral examination

Examination methods in case of permanent evaluation

Assignment, report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible

Extra information on the examination methods

End-of-term evaluation: written examination at the end of the semester.
Permanent evaluation: handed in projects.
The evaluation evaluates both the practical (programming an algorithm in a project) as well as the theoretical skills (knowledge of basic definitions, understanding of derivations, understanding of the mechanisms which make a given method better than other methods, ...).

Calculation of the examination mark

First exam period: Permanent (25%) and end-of-term evaluation (75%)
Second exam period: end-of-therm evaluation (100%).