Numerical Analysis of Ordinary Differential Equations

Fall 2023

Lecture Hours: Every Monday 14.00-16.00.

Office Hours: By appointment.

References:

1. K. Atkinson, W. Han and D. Steward, *Numerical Solution of Ordinary Differential Equations*, Wiley, 2009
2. J. Butcher, *Numerical Methods for Ordinary Differential Equations*, Second Edition, Wiley, 2008.
3. E. Hairer, G. Wanner and S. P. Nørsett, *Solving Ordinary Differential Equations I: Nonstiff Problems.* (Springer Series in Computational Mathematics, 8)
4. W. Gautschi, *Numerical analysis.* 2nd ed. Boston, MA: Birkhäuser.
5. R. Rannacher, *Numerik 1: Numerik gewöhnlicher Differentialgleichungen.* Heidelberg: Heidelberg University Publishing, 2017 (Lecture Notes).
6. V. Thomée, *Galerkin Finite Element Methods for Parabolic Problems*, Springer-Verlag, Second Edition, Berlin, 2006.

Objectives: This seminar is primarily designed for master students of Mathematics

Prerequisites: Knowledge of calculus, linear algebra, functional analysis and programming.

Content:

- Basic existence and uniqueness results for initial value problems.
- General theory of Runge-Kutta and multi-step methods: consistency, stability, convergence.
- Finite element methods for evolution equations.
- Applications to problems originating from various scientific areas.

Learning results:

- The basic results of multi-step methods and Runge-Kutta methods as well as the differences between them.
- The basic results of stability and convergence of the Runge-Kutta and multi-step methods for the numerical approximation of the solution of initial value problem.
- To implement these numerical methods for the approximation of the solution of initial value problems and to apply them to problems originating from various scientific areas.
- Also to be able to calculate the experimental order of convergence of the methods they use.

Grading Policy: Oral exams at the end of the semester.