New trends in Numerical Analysis and Scientific Computing

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Timetable: 18-20 hours. March-May 2017, Torre Archimede,

Course requirements: No special requirement is needed for this course. Only some fundamental knowledge of numerical analysis, but it could be acquired simultaneously with the lectures.

Examination and grading: Grading is based on homeworks or a written examination or both.

SSD: MAT/08 Numerical Analysis

Aim: The aim of the lectures is to introduce PhD students to some recent research subjects in numerical analysis (especially those related to approximation and numerical linear algebra) and to provide them the theoretical basis for their understanding. Applications will also be discussed. These lectures are intended to students and researchers in pure and applied mathematics, in numerical analysis, and in scientific computing.

Course contents: The various topics developed at different levels, will be

1. Formal orthogonal polynomials
   (a) Definition
   (b) Algebraic properties
   (c) Recurrence relation
   (d) Adjacent Families
2. Padé approximation
   (a) Definition and algebraic properties
   (b) Padé-type approximants
   (c) Connection to formal orthogonal polynomials
   (d) Recursive computation
   (e) Connection to continued fractions
   (f) Some elements of convergence theory
   (g) Applications
3. Krylov subspace methods
   (a) Definition
   (b) Lanczos method
   (c) Recurrence relations
   (d) Implementation
4. Extrapolation methods
   (a) Sequence transformations and convergence acceleration
   (b) What is an extrapolation method?

(c) Various extrapolation methods
(d) Vector sequence transformations
(e) Applications
    i. Treatment of the Gibbs phenomenon
    ii. Web search
    iii. Estimation of the error for linear systems
    iv. Regularization of linear systems
    v. Estimation of the trace of matrix powers
    vi. Acceleration of Kaczmarz method
    vii. Fixed point iterations
    viii. Computation of matrix functions

References

[1] Lecture notes provided to the students following the courses.

[2] C. Brezinski, *Padé–Type Approximation and General Orthogonal Polynomials*, ISNM, vol. 50, Birkhäuser–Verlag, Basel, 1980.

[3] C. Brezinski, M. Redivo-Zaglia, *Extrapolation Methods. Theory and Practice*, North–Holland, Amsterdam, 1991. C. Brezinski, *Biorthogonality and its Applications to Numerical Analysis*, Marcel Dekker, New York, 1992.

[4] C. Brezinski, *Projection Methods for Systems of Equations*, North-Holland, Amsterdam, 1997.

[5] C. Brezinski, *Computational Aspects of Linear Control*, Kluwer, Dordrecht, 2002.