Electronic Transactions on Numerical Analysis
Volume 1, 1993

Contents

Abstract. The error of the linearly implicit mid–point rule after $2m+1$ steps is expanded in powers of m^2. We prove that the well-known expansion for ordinary differential equations (an expansion in negative powers of m^2) is perturbed by additional terms with non-negative powers of m^2 for semi–explicit differential–algebraic equations of index one. Hence, extrapolation in m^{-2} will be of limited value only. The complete expansion shows these limits and, furthermore, can be used to derive an order 8 method of Rosenbrock type.

Key words. Differential–algebraic equations, linearly implicit mid–point rule, Rosenbrock–type methods, extrapolation.

AMS(MOS) subject classification. 65L05, 65B05, 58F99.

Files. vol.1.1993/pp1-10.dir/pp1-10.ps, vol.1.1993/pp1-10.dir/pp1-10.pdf

Forward References.

Abstract. For a number of linear systems of equations arising from realistic problems, using the Bi-CGSTAB algorithm of van der Vorst to solve these equations is very attractive. Unfortunately, for a large class of equations, where, for instance, Bi-CG performs well, the convergence of Bi-CGSTAB stagnates. This was observed specifically in case of discretized advection dominated PDE's. The stagnation is due to the fact that for this type of equations the matrix has almost pure imaginary eigenvalues. With his BiCGStab2 algorithm Gutknecht attempted to avoid this stagnation. Here, we generalize the Bi-CGSTAB algorithm further, and overcome some shortcomings of BiCGStab2. In some sense, the new algorithm combines GMRES(l) and Bi-CG and profits from both.

Key words. Bi-conjugate gradients, non-symmetric linear systems, CGS, Bi-CGSTAB, iterative solvers, GMRES, Krylov subspace.

AMS(MOS) subject classification. 65F10.

Files. vol.1.1993/pp11-32.dir/pp11-32.ps, vol.1.1993/pp11-32.dir/pp11-32.pdf

Forward References. vol.2.1994/pp57–75.dir/pp57–75.ps, vol.2.1994/pp57–75.dir/pp57–75.pdf, vol.2.1994/pp76–95.dir/pp76–95.ps, vol.2.1994/pp76–95.dir/pp76–95.pdf.

33 A multishift algorithm for the numerical solution of algebraic Riccati equations. *Gregory Ammar, Peter Benner, and Volker Mehrmann.*

Abstract. We study an algorithm for the numerical solution of algebraic matrix Riccati equations that arise in linear optimal control problems. The algorithm can be considered to be a multishift technique, which uses only orthogonal symplectic similarity transformations to compute a Lagrangian invariant subspace of the associated Hamiltonian matrix. We describe the details of this method and compare it with other numerical methods for the solution of the algebraic Riccati equation.

Key words. algebraic matrix Riccati equation, Hamiltonian matrix, Lagrangian invariant subspace.

AMS(MOS) subject classification. 65F15, 15A24, 93B40.

Files. vol.1.1993/pp33–48.dir/pp33–48.ps, vol.1.1993/pp33–48.dir/pp33–48.pdf

Forward References.

49 Zeros and local extreme points of Faber polynomials associated with hypocycloidal domains. *Michael Eiermann and Richard S. Varga.*

Abstract. Faber polynomials play an important role in different areas of constructive complex analysis. Here, the zeros and local extreme points of Faber polynomials for hypocycloidal domains are studied. For this task, we use tools from linear algebra, namely, the Perron-Frobenius theory of nonnegative matrices, the Gantmacher-Krein theory of oscillation matrices, and the Schmidt-Spitzer theory for the asymptotic spectral behavior of banded Toeplitz matrices.

Key words. Faber polynomials, cyclic of index p matrices, oscillation matrices.

AMS(MOS) subject classification. 30C15, 15A48, 15A57.

Files. vol.1.1993/pp49–71.dir/pp49–71.ps, vol.1.1993/pp49–71.dir/pp49–71.ps.

Forward References.

72 Numerical methods for the computation of analytic singular value decompositions. *Volker Mehrmann and Werner Rath.*

Abstract. An analytic singular value decomposition (ASVD) of a path of matrices $E(t)$ is an analytic path of factorizations $E(t) = X(t)S(t)Y(t)^T$ where $X(t)$ and $Y(t)$ are orthogonal and $S(t)$ is diagonal. The diagonal entries of $S(t)$ are allowed to be either positive or negative and to appear in any order. For an analytic path matrix $E(t)$ an ASVD exists, but this ASVD is not unique. We present two new numerical methods for the computation of unique ASVD's. One is based on a completely algebraic approach and the other on one step methods for ordinary differential equations in combination with projections into the set of orthogonal matrices.

Key words. analytic singular value decomposItion, singular value decomposition.

AMS(MOS) subject classification. 65F25.

Files. vol.1.1993/pp72–88.dir/pp72–88.ps, vol.1.1993/pp72–88.dir/pp72–88.ps.

Forward References.

89 A Chebyshev-like semiiteration for inconsistent linear systems. *Martin Hanke and Marlis Hochbruck.*

Abstract. Semiiterative methods are known as a powerful tool for the iterative solution of nonsingular linear systems of equations. For singular but consistent linear systems with coefficient matrix of index one, one can still apply the methods designed for the nonsingular case. However, if the system is inconsistent, the approximations usually fail to converge. Nevertheless, it is still possible to modify classical methods like the Chebyshev semiiterative method in order to fulfill the additional convergence requirements caused by the inconsistency. These modifications may suffer from instabilities since they are based on the computation of the diverging Chebyshev iterates. In this paper we develop an alternative algorithm which allows to construct more stable approximations. This algorithm can be efficiently implemented with short recurrences. There are several reasons indicating that the new algorithm is the most natural generalization of the Chebyshev semiiteration to inconsistent linear systems.

Key words. Semiiterative methods, singular systems, Zolotarev problem, orthogonal polynomials.

AMS(MOS) subject classification. 65F10, 65F20.

Files. vol.1.1993/pp89–103.dir/pp89–103.ps, vol.1.1993/pp89–103.dir/pp89–103.ps.

Forward References.

104 A new lehmer pair of zeros and a new lower bound for the de Bruijn-Newman constant Λ. *G. Csordas, A.M. Odlyzko, W. Smith, and R. S. Varga.*

Abstract. The de Bruijn-Newman constant Λ has been investigated extensively because the truth of the Riemann Hypothesis is equivalent to the assertion that $\Lambda \leq 0$. On the other hand, C. M. Newman conjectured that $\Lambda \geq 0$. This paper improves previous lower bounds by showing that

$$-5.895 \cdot 10^{-9} < \Lambda.$$

This is done with the help of a spectacularly close pair of consecutive zeros of the Riemann zeta function.

Key words. Lehmer pairs of zeros, de Bruijn-Newman constant, Riemann Hypothesis.

AMS(MOS) subject classification. 30D10, 30D15, 65E05.

Files. vol.1.1993/pp104-111.dir/pp104-111.ps, vol.1.1993/pp104-111.dir/pp104-111.pdf, vol.1.1993/pp104-111.dir/pp104-111orig.ps

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