

Bibliography

- A. Aho, R. Sethi, and J. Ullman [1988]. *Compilers*. Addison-Wesley, Reading, MA.
- E. Allgower and K. Georg (eds.) [1990]. *Computational Solution of Nonlinear Systems of Equations*. American Mathematical Society, Providence, RI.
- E. Allgower and K. Georg [1990]. *Numerical Continuation Methods*. Springer-Verlag, New York.
- W. Ames [1977]. *Numerical Methods for Partial Differential Equations*. Academic Press, New York.
- M. Arioli, J. Demmel, and I. Duff [1989]. Solving Sparse Linear Systems with Sparse Backward Error. *SIAM J. Matrix Anal. Appl.*, 10: pp. 165–190.
- U. Ascher, R. Mattheij, and R. Russell [1988]. *Numerical Solution of Boundary Value Problems for Ordinary Differential Equations*. Prentice-Hall, Englewood Cliffs, NJ.
- O. Axelsson and V. Barker [1984]. *Finite Element Solution of Boundary Value Problems*. Academic Press, Orlando.
- E. Becker, G. Carey, and J. Oden [1981]. *Finite Elements, An Introduction*. Prentice-Hall, Englewood Cliffs, NJ.
- J. Bramble and B. Hubbard [1964]. New Monotone Type Approximations for Elliptic Problems. *Math. Comp.*, 18: pp. 349–367.
- K. Brenan, S. Campbell, and L. Petzold [1989]. *Numerical Solution of Initial-Value Problems in Differential-Algebraic Equations*. American Elsevier, New York.
- W. Briggs [1987]. *A Multigrid Tutorial*. SIAM, Philadelphia.
- P. Brown, G. Byrne, and A. Hindmarsh [1989]. VODE: A Variable Coefficient ODE Solver. *SIAM J. Sci. Stat. Comp.*, 10: pp. 1038–1051.

- J. Butcher [1987]. *The Numerical Analysis of Ordinary Differential Equations*. John Wiley & Sons, New York.
- G. Carey and J. Oden [1984]. *Finite Elements, Computational Aspects*. Prentice-Hall, Englewood Cliffs, NJ.
- B. Char, K. Geddes, G. Gonnet, and S. Watt [1985]. *First Leaves: A Tutorial Introduction to MAPLE, in MAPLE User's Guide*. Watcom Publications Ltd., Waterloo, Ontario.
- R. Courant and D. Hilbert [1953 , 1962]. *Methods of Mathematical Physics*, volume 1 and 2. Interscience, New York.
- J. Daniel and R. Moore [1970]. *Computation and Theory in Ordinary Differential Equations*. Freeman, San Francisco.
- P. Davis and P. Rabinowitz [1984]. *Methods of Numerical Integration*. Academic Press, New York.
- C. de Boor [1978]. *A Practical Guide to Splines*. Springer-Verlag, New York.
- J. Dennis and J. Moré [1977]. Quasi-Newton Methods: Motivation and Theory. *SIAM Review*, 19: pp. 46–89.
- J. Dennis and R. Schnabel [1983]. *Numerical Methods for Unconstrained Optimization and Nonlinear Equations*. Prentice-Hall, Englewood Cliffs, NJ.
- J. Dongarra, E. Anderson, Z. Bai, A. Greenbaum, A. McKenney, J. DuCroz, S. Hammerling, J. Demmel, C. Bischof, and D. Sorensen [1990]. *LAPACK: A Portable Linear Algebra Library for High Performance Computers*. Proc. Supercomputing '90, IEEE Computer Society Press, Washington, DC.
- J. Dongarra, J. Bunch, C. Moler, and G. Stewart [1979]. *LINPACK Users' Guide*. SIAM, Philadelphia.
- J. Dongarra, I. Duff, D. Sorensen, and H. van der Vorst [1990]. *Solving Linear Systems on Vector and Shared Memory Computers*. SIAM, Philadelphia.
- I. Duff, A. Erisman, and J. Reid [1986]. *Direct Methods for Sparse Matrices*. Oxford University Press, Oxford.
- A. Edelman and M. Ohlrich [1991]. *Editors Note*. SIAM J. Mat. Anal. Appl. 12, no.3.
- R. Elmasri and S. Navathe [1989]. *Fundamentals of Database Systems*. Benjamin/Cummings Publishing Co., Menlo Park, CA.
- C. Fischer and R. LeBlanc Jr. [1988]. *Crafting a Compiler*. Benjamin/Cummings Publishing Co., Menlo Park, CA.

- G. Forsythe and W. Wasow [1960]. *Finite Difference Methods for Partial Differential Equations*. Wiley, New York.
- J. Francis [1961, 1962]. The QR Transformation, Parts I & II. *Computer Journal*, 4: pp. 265-271, 332-345.
- R. Friedhoff and W. Benzon [1989]. *Visualization*. Henry N. Abrams, Inc., New York.
- P. Garabedian [1986]. *Partial Differential Equations; 2nd Edition*. Chelsea, New York.
- B. Garbow, J. Boyle, J. Dongarra, and C. Moler [1977]. *Matrix Eigensystem Routines - EISPACK Guide Extension*, volume 51. Springer-Verlag, New York.
- C. W. Gear [1971]. *Numerical Initial Value Problems in Ordinary Differential Equations*. Prentice-Hall, Englewood Cliffs, NJ.
- A. George and J. Liu [1981]. *Computer Solution of Large Sparse Positive Definite Systems*. Prentice-Hall, Englewood Cliffs, NJ.
- G. Golub and C. Van Loan [1989]. *Matrix Computations, Second Edition*. Johns Hopkins Press, Baltimore.
- N. Gould [1991]. On Growth in Gaussian Elimination with Complete Pivoting. *SIAM J. Mat. Anal. Appl.*, 12: pp. 354-361.
- A. Griewank [1989]. *On Automatic Differentiation*. In "Mathematical Programming: Recent Developments and Applications," M. Iri and K. Tanabe (eds.), Kluwer Academic Publishers, Norwell, MA.
- A. Griewank [1990]. *Direct Calculation of Newton Steps without Accumulating Jacobians*. In "Large Scale Optimization," T. Coleman and G. Li (eds.), SIAM, Philadelphia.
- R. Haberman [1983]. *Elementary Applied Partial Differential Equations*. Prentice-Hall, Englewood Cliffs, NJ.
- W. Hackbusch [1985]. *Multigrid Methods with Applications*. Springer-Verlag, New York.
- L. Hageman and D. Young [1981]. *Applied Iterative Methods*. Academic Press, New York.
- W. Hager [1989]. Updating the Inverse of a Matrix. *SIAM Review*, 31: pp. 221-239.

- E. Hairer, C. Lubich, and M. Roche [1989]. *The Solution of Differential-Algebraic Systems by Runge-Kutta Methods*. Springer-Verlag, New York.
- E. Hairer, S. Norsett, and G. Wanner [1987]. *Solving Ordinary Differential Equations: I. Non-Stiff Problems*. Springer-Verlag, New York.
- C. Hall and T. Porsching [1990]. *Numerical Analysis of Partial Differential Equations*. Prentice-Hall, Englewood Cliffs, NJ.
- J. Hennessy and J. Patterson [1990]. *Computer Architecture: A Quantitative Approach*. Morgan Kaufman Publishers, Inc., San Mateo, CA.
- P. Henrici [1962]. *Discrete Variable Methods in Ordinary Differential Equations*. Wiley, New York.
- M. Hestenes and E. Stiefel [1952]. Methods of Conjugate Gradients for Solving Linear Systems. *Journal of Research of the National Bureau of Standards*, 49: pp. 409–436.
- N. Higham [1990]. Exploiting Fast Matrix Multiplication within the Level 3 BLAS. *ACM Trans. Math Softw.*, 16: pp. 352–368.
- A. Hindmarsh [1983]. *ODEPACK, A Systematized Collection of ODE Solvers*. In “Scientific Computing”, R. Stepleman (ed.), North Holland, Amsterdam.
- R. Hockney and C. Jesshope [1988]. *Parallel Computers 2*. Adam Hilger, Bristol and Philadelphia.
- A. Householder [1964]. *The Theory of Matrices in Numerical Analysis*. Ginn (Blaisdell), Boston.
- E. Isaacson and H. Keller [1966]. *Analysis of Numerical Methods*. Wiley, New York.
- J. Keener [1988]. *Principles of Applied Mathematics*. Addison-Wesley Publishing Co., Reading, MA.
- H. Keller [1968]. *Numerical Methods for Two-Point Boundary Value Problems*. Ginn (Blaisdell), New York.
- V. Kublanovskaya [1961]. On Some Algorithms for the Solution of the Complete Eigenvalue Problem. *Zh. Vych. Mat.*, 1: pp. 555–570.
- J. Lambert [1973]. *Computational Methods in Ordinary Differential Equations*. Wiley, New York.
- J. LaSalle and S. Lefschetz [1961]. *Stability by Liapunov's Direct Method*. Academic Press, New York.

- C. Lawson and R. Hanson [1974]. *Solving Least Squares Problems*. Prentice-Hall, Englewood Cliffs, NJ.
- R. Mendez (ed.) [1990]. *Visualization in Supercomputing*. Springer Verlag, New York.
- G. Meyer [1973]. *Initial Value Methods for Boundary Value Problems; Theory and Application of Invariant Imbedding*. Academic Press, New York.
- C. Moler and G. Stewart [1973]. An Algorithm for Generalized Matrix Eigenvalue Problems. *SIAM J. Numer. Anal.*, 10: pp. 241-256.
- W. Newman and R. Sproul [1979]. *Principles of Interactive Computer Graphics (2nd Edition)*. McGraw-Hill, New York.
- J. Ortega [1987]. *Matrix Theory: A Second Course*. Plenum Press, New York.
- J. Ortega [1988]. *Introduction to Parallel and Vector Solution of Linear Systems*. Plenum Press, New York.
- J. Ortega [1990]. *Numerical Analysis: A Second Course*. Reprint of 1972 original. SIAM, Philadelphia.
- J. Ortega and W. Rheinboldt [1970]. *Iterative Solution of Nonlinear Equations in Several Variables*. Academic Press, New York.
- B. Parlett [1980]. *The Symmetric Eigenvalue Problem*. Prentice-Hall, Englewood Cliffs, NJ.
- J. Peterson and J. Silberschatz [1985]. *Operating Systems Concepts, 2nd Edition*. Addison-Wesley Publishing Co., Reading, MA.
- T. Pratt [1984]. *Programming Languages*. Prentice-Hall, Englewood Cliffs, NJ.
- P. Prenter [1975]. *Splines and Variational Methods*. Wiley, New York.
- G. Rayna [1987]. *Software for Algebraic Computation*. Springer-Verlag, New York.
- R. Richtmyer and K. Morton [1967]. *Difference Methods for Initial Value Problems*. Interscience-Wiley, New York.
- P. Roache [1972]. *Computational Fluid Dynamics*. Hermosa Publishers, Albuquerque, NM.
- S. Roberts and J. Shipman [1972]. *Two-Point Boundary Value Problems: Shooting Methods*. American Elsevier, New York.

- J. Rosser, R. Newton, and G. Gross [1974]. *The Mathematical Theory of Rocket Flight*. McGraw-Hill, New York.
- S. Rubinow [1975]. *Introduction to Mathematical Biology*. Wiley-Interscience, New York.
- W. Schiesser [1991]. *Numerical Method of Lines*. Academic Press, New York.
- R. Sethi [1989]. *Programming Languages*. Addison-Wesley, Reading, MA.
- L. Shampine and M. Gordon [1976]. *Computer Solutions of Ordinary Differential Equations: The Initial Value Problem*. W. H. Freeman, San Francisco.
- L. Shampine, H. Watts, and S. Davenport [1976]. Solving Nonstiff Ordinary Differential Equations - The State of the Art. *SIAM Review*, 18: pp.376-411.
- J. Shosmith [1973]. *A Study of Monotone Matrices with an Application to the High-Order Finite Difference Solution of a Linear Two-Point Boundary Value Problem*. Ph.D. Thesis, Applied Mathematics, University of Virginia.
- R. Skeel [1980]. Iterative Refinement Implies Numerical Stability for Gaussian Elimination. *Math. Comp.*, 35: pp. 817-832.
- G. W. Stewart [1973]. *Introduction to Matrix Computations*. Academic Press, New York.
- G. W. Stewart [1974]. Modifying Pivot Elements in Gaussian Elimination. *Math. Comp.*, 28: pp. 527-542.
- G. W. Stewart and J.-G. Sun [1990]. *Matrix Perturbation Theory*. Academic Press, New York.
- G. Strang and G. Fix [1973]. *An Analysis of the Finite Element Method*. Prentice-Hall, Englewood Cliffs, NJ.
- V. Strassen [1969]. Gaussian Elimination Is Not Optimal. *Numerische Mathematik*, 13: pp. 354-356.
- A. Stroud [1971]. *Approximate Calculation of Multiple Integrals*. Prentice-Hall, Englewood Cliffs, NJ.
- Symbolics [1987]. *Macsyma User's Guide*. Symbolics, Inc., Cambridge, MA.
- J. Traub [1964]. *Iterative Methods for the Solution of Equations*. Prentice-Hall, Englewood Cliffs, NJ.
- R. Varga [1962]. *Matrix Iterative Analysis*. Prentice-Hall, Englewood Cliffs, NJ.

- J. Wilkinson [1961]. Error Analysis of Direct Methods of Matrix Inversion. *J. Assoc. Comput. Mach.*, 10: pp. 281–330.
- J. Wilkinson [1963]. *Rounding Errors in Algebraic Processes*. Prentice-Hall, Englewood Cliffs, NJ.
- J. Wilkinson [1965]. *The Algebraic Eigenvalue Problem*. Oxford University Press (Clarendon), London and New York.
- S. Wolfram [1988]. *A System for Doing Mathematics by Computer*. Addison-Wesley, Redwood City, CA.
- E. Yip [1986]. A Note on the Stability of Solving a Rank p Modification of a Linear System by the Sherman-Morrison-Woodbury Formula. *SIAM J. Sci. Stat. Comput.*, 7: pp. 507–513.
- D. Young [1950]. *Iterative Methods for Solving Partial Difference Equations of Elliptic Type*. Ph.D. Thesis, Harvard University.
- D. Young [1971]. *Iterative Solution of Large Linear Systems*. Academic Press, New York.
- D. Young and R. Gregory [1990]. *A Survey of Numerical Mathematics*, volume 1 and 2. Chelsea Publishing Co., New York.
- D. Young and T.-Z. Mai [1990]. *The Search for Omega*. In “Iterative Methods for Large Linear Systems,” D. Kincaid and L. Hayes (eds.), Academic Press, New York.

Author Index

A

- Aho, A., 14, 321
Allgower E., 176, 321
Ames, W., 261, 321
Anderson, E., 14, 131, 231, 322
Arioli, M., 131, 321
Ascher, U., 78, 79, 149, 185, 209, 321
Axelsson, O., 282, 321

B

- Bai, Z., 322
Bailey, D., 110
Barker, V., 282, 321
Bartlett, M., 86
Becker, E., 282, 321
Benzon, W., 14, 323
Bischof, C., 322
Boyle, J., 323
Bramble, J., 77, 321
Brenan, K., 36, 321
Briggs, W., 305, 321
Brown, P., 64, 321
Bunch, J., 322
Butcher, J., 35, 36, 53, 64, 322
Byrne, G., 64, 321

C

- Campbell, S., 36, 321
Carey, G., 282, 321, 322
Char, B., 14, 322

Courant, R., 252, 322

D

- Dahlquist, G., 64
Daniel, J., 35, 322
Davenport, S., 36, 153, 326
Davis, P., 201, 322
deBoor, C., 193, 209, 322
Demmel, J., 321, 322
Dennis, J., 174, 322
Dongarra, J., 14, 131, 231, 322, 323
DuCroz, J., 322
Duff, I., 14, 290, 321, 322

E

- Edelman, A., 120, 322
Elmasri, R., 14, 322
Erisman, A., 322

F

- Fischer, C., 14, 322
Fix, G., 185, 209, 282, 326
Forsythe, G., 282, 323
Francis, J., 231, 323
Friedhoff, R., 14, 323

G

- Garabedian, P., 252, 323
Garbow, B., 14, 231, 323

Gear, C. W., 53, 64, 323
 Geddes, K., 322
 Georg, K., 176, 321
 George, A., 289, 323
 Givens, J., 231
 Golub, G., 100, 110, 119, 132, 141,
 221, 231, 244, 305
 Gonnet, G., 322
 Gordon, M., 326
 Gould, N., 120, 323
 Greenbaum, A., 322
 Gregory, R., 44, 327
 Griewank, A., 174, 323
 Gross, G., 20, 326

H

Haberman, R., 252, 323
 Hackbrush, W., 305, 323
 Hageman, L., 303, 323
 Hager, W., 86, 323
 Hairer, E., 35, 36, 324
 Hall, C., 186, 209, 261, 282, 324
 Hammerling, S., 322
 Hanson, R., 100, 141, 325
 Hennessy, J., 14, 324
 Henrici, P., 35, 53, 63, 324
 Hestenes, M., 305, 324
 Higham, N., 110, 324
 Hilbert, D., 252, 322
 Hindmarsh, A., 52, 64, 321, 324
 Hockney, R., 290, 324
 Householder, A., 221, 231, 324
 Hubbard, B., 77, 321

I

Isaacson, E., 261, 324
 J
 Jesshope, C., 290, 324

K

Keener, J., 252, 324
 Keller, H., 79, 261, 324
 Kublanovskaya, V., 231, 324

M

Mai, T., 303, 327
 Mattheij, R., 321
 McKenney, A., 322
 Mendez, R., 14, 325
 Meyer, G., 14, 325
 Moler, C., 231, 322, 323, 325
 Moore, R., 35, 322
 Moré, J., 174, 322
 Morrison, W., 86
 Morton, K., 261, 265, 282, 325

N

Navathe, S., 14, 322
 Newman, W., 14, 325
 Newton, R., 20, 326
 Norsett, S., 35, 324

O

Oden, J., 282, 321, 322
 Ohlrich, M., 120, 322
 Ortega, J., 63, 79, 119, 174, 176,
 221, 232, 290, 304, 305, 325

P

Parlett, B., 221, 231, 232, 244, 325
 Patterson, J., 14, 324
 Peterson, J., 14, 325
 Petzold, L., 36, 321
 Porschning, T., 186, 209, 261, 282,
 324
 Pratt, T., 14, 325
 Prenter, P., 186, 193, 209, 325

R

- Rabinowitz, P., 201, 322
Rayna, G., 14, 325
Reid, J., 322
Rheinboldt, W., 174, 176, 305, 325
Richtmyer, R., 261, 265, 282, 325
Roache, P., 282, 325
Roberts, S., 149, 325
Roche, M., 36, 324
Rosser, J., 20, 326
Rubinow, S., 20, 326
Russell, R., 321
Rutishauser, H., 231

S

- Schiesser, W., 272, 326
Schnabel, R., 174, 322
Sethi, R., 14, 321, 326
Shampine, L., 36, 53, 326
Sherman, J., 86
Shipman, J., 149, 325
Shoosmith, J., 77, 326
Silberschatz, J., 14, 325
Skeel, R., 131, 326
Sorensen, D., 322
Sproul, R., 14, 325
Stewart, G. W., 131, 141, 221, 231,
 244, 245, 322, 325, 326
Stiefel, E., 305, 324
Strang, G., 185, 209, 282, 326
Strassen, V., 110, 326
Stroud, A., 201, 326
Sun, J., 131, 326

T

- Traub, J., 153, 326

U
Ullman, J., 14, 321

V
van der Vorst, H., 322
Van Loan, C., 100, 110, 119, 131,
 141, 221, 231, 244, 305, 323

W
Varga, R., 282, 303, 326

W
Wanner, G., 35, 324
Wasow, W., 282, 323
Watt, S., 322
Watts, H., 36, 53, 326
Weissinger, J., 304
Wilkinson, J., 119, 163, 221, 231,
 232, 244, 327
Wolfram, S., 14, 327
Woodbury, M., 87

Y
Yip, E., 327
Young, D., 44, 303, 305, 323, 327

Subject Index

A

- Adams-Basforth methods, 45*ff*
- Adams-Moulton methods, 47*ff*, 156
- Adjoint equation, 163
- Alternating direction method, 281
- Arrowhead matrix, 286*ff*
- Asymptotically stable solution, 217
- Automatic differentiation, 174

B

- B-spline, 203*ff*
- Back substitution, 102*ff*
- Backward differentiation formula, 64
- Backward error analysis, 8, 115
- Backward Euler method, 62
- Bairstow's method, 163
- Balancing, 117
- Ballistics problem, 16
- Banded matrix, 106, 118
- Bandwidth, 106
- Basis functions, 179
- Bidiagonal matrix, 108
- Bisection method, 150
- Block tridiagonal matrix, 278
- Boundary condition, 4, 248
- Boundary-value problem, 67*ff*
 - nonlinear, 171
- Bunch-Kaufman algorithm, 141

C

- Catastrophic cancellation, 8
- Chain rule, 309
- Characteristic equation, 58
- Characteristic polynomial, 211, 314
- Cholesky factorization, 133, 285
- Chord method, 154
- Collocation, 180*ff*, 202*ff*
- Companion matrix, 163, 223
- Complete pivoting, 119
- Composite formulas, 197*ff*
- Computational complexity, 10
- Computational engineering, 1
- Computational science, 1
- Computer science, 3
- Condition number, 128*ff*
- Conjugate gradient method, 300*ff*
 - preconditioned, 301
- Conjugate vectors, 301
- Consistency, 53, 255, 295
- Consistently ordered matrix, 298
- Continuation method, 175
- Convergence error, 9
- Convergence factor, 159
- Convergence theory, 154*ff*, 168*ff*
- Convex function, 157
- Crank-Nicolson method, 264
- Crout form, 105
- Cubic spline, 189*ff*
- Cyclic reduction algorithm, 290

D

- Davidenko's method, 175
 Data management, 13
 Deferred correction, 77
 Deflation, 236
 Determinant, 109, 124
 Diagonal matrix, 316
 Diagonally dominant matrix, 72, 118, 120, 173, 295
 Difference equation, 57*ff*
 Differential equation, 311*ff*
 Differential-algebraic system, 36
 Diffusion equation, 247
 Direction vector, 300
 Dirichlet boundary condition, 75, 275
 Discretization error, 8, 23*ff*, 48*ff*, 70*ff*, 254*ff*, 264
 Domain decomposition, 286
 Doolittle form, 105

E

- Efficiency, 9
 Eigenvalue, 211, 314
 ill conditioned, 220
 Eigenvalue problem, 211
 generalized, 216, 231
 Eigenvector, 211, 314
 computation of, 229*ff*, 236*ff*
 EISPACK, 11, 14, 231
 Elementary reflection matrix, 137
 Elliptic equation, 247, 252
 Elliptic norm, 317
 Equilibration, 116
 Euler equation, 185
 Euler's method, 22*ff*, 61, 199, 268
 Explicit method, 48, 253*ff*

F

- Fast Fourier transform, 290
 Fast Poisson solver, 290
 Fill, 283
 Finite element method, 282
 Finite difference method, 21, 67*ff*
 Fortran, 12
 Forward reduction, 102*ff*
 Fourier series, 251
 Frobenius matrix, 223

G

- Galerkin method, 181*ff*, 206*ff*
 Gaussian elimination, 81*ff*, 101*ff*, 283*ff*
 Gaussian quadrature, 200
 Gauss-Seidel method, 292
 Geometric convergence, 159
 Gershgorin's theorem, 217*ff*
 Givens transformation, 135
 Global convergence, 157
 Gradient vector, 310
 Grid points, 21, 68

H

- Hankel matrix, 92
 Hat function, 207
 Heat equation, 247*ff*, 253*ff*, 273*ff*, 279*ff*
 Hessenberg matrix, 121, 225*ff*, 238
 Heun method, 26*ff*
 Higher-order differences, 77
 Hilbert matrix, 127
 Householder's method, 229
 Householder reduction, 138*ff*
 Householder transformation, 137, 226
 Householder-John theorem, 304
 Hyperbolic equation, 247, 252, 269

I

- IEEE standard, 12
 Ill-conditioning, 8, 56, 122*ff*, 161
 Implicit method, 48, 262*ff*
 Incomplete Cholesky factorization, 302
 Initial condition, 4, 16, 248
 Inner product, 317
 Instability, 113*ff*, 147*ff*
 Interchanges, 112*ff*
 Interpolation, 37*ff*
 error, 39
 Interval of uncertainty, 151
 Inverse, 109
 Inverse iteration, 236
 Irreducible matrix, 78
 Irreducibly diagonally dominant matrix, 79
 Iterative refinement, 131

J

- Jacobi's method, 230, 292
 Jacobian matrix, 168
 Jordan elimination, 112
 Jordan form, 214*ff*, 304

L

- Lagrange polynomials, 38
 Laguerre's method, 163
 Lanczos' method, 241*ff*
 LAPACK, 11, 14, 130, 131, 231
 Laplace's equation, 247
 Large sparse matrix, 279
 Lax equivalence theorem, 258
 Least squares problems, 89*ff*, 139*ff*
 Linear convergence, 159
 Linear multistep methods, 49
 Linearly independent eigenvectors, 212*ff*
 LINPACK, 11, 14, 130, 131
 Lotka-Volterra equations, 16

l_p norm, 317

LU factorization, 103*ff*, 112, 285

M

- MACSYMA, 13
 Maintainability, 11
 MAPLE, 13
 MATHEMATICA, 13
 Mathematical model, 3
 validation, 5
 Mathematics, 3
 MATLAB, 11, 14
 Matrix norm, 319
 Mean value theorem, 309, 310
 Method of lines, 271*ff*
 Method of undetermined coefficients, 199
 Mid-point rule, 37, 194*ff*
 Milne's method, 64
 Minimization, 175
 Minimum degree algorithm, 289
 Mixed-type equation, 252
 Modeling, 4
 Multigrid method, 304
 Multistep method, 45*ff*, 154
 Murnaghan-Wintner theorem, 215

N

- Natural cubic spline, 189
 Natural ordering, 277
 Nested dissection, 288
 NETLIB, 14
 Neumann boundary condition, 75, 275
 Newton-Cotes formulas, 194*ff*
 Newton form of interpolation, 42
 Newton's method, 153*ff*, 168*ff*, 232
 Nonlinear equations, 145*ff*, 184*ff*
 Nonsingular matrix, 315
 Norm equivalence theorem, 319

Normal equations, 92
 Norm, 128, 317
 Numerical analysis, 2
 Numerical integration, 193 ff
 Numerical mathematics, 2

O

ODEPACK, 52
 One-sided differences, 73
 One-step method, 20 ff , 27 ff , 154, 295
 One-way dissection, 288
 Operation count, 82, 105, 107, 109,
 136, 138
 Order of method, 28
 Orthogonal functions, 182
 Orthogonal matrix, 134 ff , 318
 Orthogonal polynomials, 94 ff
 Orthogonal vectors, 318
 Ostrowski theorem, 298
 Ostrowski-Reich theorem, 304

P

Parabolic equation, 247, 252
 Parallel computer, 12
 Partial pivoting, 116
 Particular solution, 58
 Peaceman-Rachford method, 281
 Perfectly conditioned matrix, 124, 126
 Periodic boundary condition, 76, 84 ff
 Permutation matrix, 117
 Perturbation method, 19
 Picard iteration, 167
 Piecewise polynomial, 40 ff , 187 ff
 Piecewise quadratic, 187 ff
 Plane rotation matrix, 135
 Poisson's equation, 247, 275 ff
 Portability, 11
 Positive real matrix, 122
 Positive definite matrix, 92, 118,
 120, 173, 297, 313

Power method, 234 ff
 Preconditioning, 302
 Predator-prey equations, 15, 31, 50
 Predictor-corrector method, 48
 Principle submatrix, 316
 Projectile problem, 145
 Projection method, 179 ff
 Property A, 298

Q

QR factorization, 134, 285
 QR method, 224 ff , 235
 Quadratic convergence, 159
 Quadrature rules, 194 ff
 Quasi-Newton method, 174
 Quintic spline, 206
 QZ method, 231

R

Rank, 315
 Rank-one matrix, 84
 Rayleigh quotient, 239
 Rayleigh-Ritz method, 185
 Rectangle rule, 194 ff
 REDUCE, 13
 Reducible matrix, 78
Regula falsi method, 153
 Reliability, 10
 Reordering, 286
 Reorthogonalization, 244
 Residual function, 182
 Residual vector, 127
 Richardson extrapolation, 36, 77,
 200
 Richardson's method, 300
 Robustness, 10
 Romberg integration, 200
 Root-free Cholesky, 141
 Rounding error, 7, 30

Runge-Kutta method, 26*ff*, 199
 Runge-Kutta-Fehlberg method, 36

S

Schur's theorem, 215
 Scientific computing, 1, 2
 Secant method, 152*ff*
 Self-adjoint equation, 78
 Semi-bandwidth, 106
 Semi-discrete method, 267*ff*
 Separation of variables, 249*ff*, 256*ff*
 Separator set, 286
 Sherman-Morrison formula, 85, 112
 Sherman-Morrison-Woodbury
 formula, 86, 112
 Shifting in *QR* method, 227*ff*
 Shooting method, 146*ff*, 162*ff*
 Similar matrices, 213
 Simpson's rule, 195*ff*
 Skew-symmetric matrix, 223
 SOR method, 297
 Spectral radius, 316
 Spectrum, 316
 Spectrum splicing, 232
 Spline functions, 187*ff*, 203*ff*
 Stability, 55, 59, 255, 263
 Stability condition, 258
 Stable method, 60
 Stationary method, 295
 Stationary state, 19
 Steepest descent method, 300
 Stencil, 265, 276
 Step-size, 31
 Stiff equation, 61, 269
 Strongly stable method, 60
 Sturm sequence, 232
 Submatrix, 316
 Subspace iteration, 244
 Symbolic computation, 13, 170
 Symmetric differencing, 78
 Symmetric matrix, 74
 System of differential equations, 30

System of nonlinear equations, 166

T

Taylor expansion, 309
 Taylor series method, 34
 Three-term recurrence, 97
 Threshold pivoting, 290
 Time-splitting method, 281
 Trajectory problem, 52
 Transpose, 315
 Trapezoid rule, 63, 194*ff*
 Triangle inequality, 317
 Triangular matrix, 316
 Tridiagonal matrix, 69
 Two-point boundary-value
 problem, 67*ff*

U

Unconditionally stable, 264
 Unitary matrix, 215
 Unit sphere, 317
 Unit triangular matrix, 103
 Unstable method, 56*ff*
 Unstable solution, 55*ff*
 Upwind differences, 73

V

Vandermonde matrix, 42, 92
 Variational principle, 185
 Vector computer, 12
 Visualization, 13

W

Wave equation, 247*ff*, 259*ff*
 Weakly-stable method, 60
 Well-conditioned problem, 129