

CONTENTS

Preface, ix

Acknowledgments, xiii

1. PRELIMINARIES

1. The Space \mathcal{R}^n , 2
2. Linear Independence, Subspaces, and Bases, 9
3. Matrices, 20
4. Operations with Matrices, 29
5. Linear Transformations and Matrices, 46
6. Linear Equations and Inverses, 54
7. A Matrix Reduction and Some Consequences, 63

2. PRACTICALITIES

1. Errors, Arithmetic, and Stability, 69
2. An Informal Language, 83
3. Coding Matrix Operations, 93

3. THE DIRECT SOLUTION OF LINEAR SYSTEMS

1. Triangular Matrices and Systems, 106
2. Gaussian Elimination, 113
3. Triangular Decomposition, 131
4. The Solution of Linear Systems, 144
5. The Effects of Rounding Error, 148

4. NORMS, LIMITS, AND CONDITION NUMBERS

1. Norms and Limits, 161
2. Matrix Norms, 173
3. Inverses of Perturbed Matrices, 184
4. The Accuracy of Solutions of Linear Systems, 192
5. Iterative Refinement of Approximate Solutions of Linear Systems, 200

5. THE LINEAR LEAST SQUARES PROBLEM

1. Orthogonality, 209
2. The Linear Least Squares Problem, 217
3. Orthogonal Triangularization, 230
4. The Iterative Refinement of Least Squares Solutions, 245

6. EIGENVALUES AND EIGENVECTORS

1. The Space \mathbb{C}^n , 251
2. Eigenvalues and Eigenvectors, 262
3. Reduction of Matrices by Similarity Transformations, 275
4. The Sensitivity of Eigenvalues and Eigenvectors, 289
5. Hermitian Matrices, 307
6. The Singular Value Decomposition, 317

7. THE QR ALGORITHM

1. Reduction to Hessenberg and Tridiagonal Forms, 328
2. The Power and Inverse Power Methods, 340
3. The Explicitly Shifted QR Algorithm, 351
4. The Implicitly Shifted QR Algorithm, 368
5. Computing Singular Values and Vectors, 381
6. The Generalized Eigenvalue Problem $A - \lambda B$, 387

Appendix 1. The Greek Alphabet and Latin Notational Correspondents, 395

Appendix 2. Determinants, 396

Appendix 3. Rounding-Error Analysis of Solution of Triangular Systems and of Gaussian Elimination, 405

Appendix 4. Of Things Not Treated, 413

Bibliography, 417

Index of Notation, 425

Index of Algorithms, 427

Index, 429