Contents

Chapter 1. Vectors and Matrices 1
1.1 Introduction 1
1.2 Comparison of Matrices 7
1.3 Elementary Matrix Algebra 8
1.4 Inverse of a Matrix 21
1.5 Further Examples and Applications 24
1.6. Exercises 52

Chapter 2. Vector Spaces and Inner-Product Spaces 57
2.1 Introduction 57
2.2 Subspaces 62
2.3 Linear Independence, Basis 70
2.4 Inner-Product Spaces 85
2.5 Direct Sums and Orthogonal Complementary Subspaces 105
2.6 Applications 119
2.7 Exercises 127

Chapter 3. Systems of Linear Equations and Inverses of Matrices 133
3.1 Introduction 133
3.2 Existence and Uniqueness of a Solution 135
3.3 Systems of Homogeneous Linear Equations 142
3.4 Systems of Inhomogeneous Linear Equations 149
3.5 Rank of Matrices 155
3.6 Matrix Equations and Inverses of Matrices 157
3.7 The Elimination Method 165
3.8 Applications 188
3.9 Exercises 200

Chapter 4. Determinants 207
4.1 Introduction 207
4.2 Properties of Determinants 215

4.3 Cofactors and Expansion by Cofactors 225
4.4 Determinants and Systems of Linear Equations 232
4.5 Further Examples and Applications 238
4.6 Exercises 245

Chapter 5. Linear Mappings and Matrices 251
5.1 Introduction 251
5.2 Vector Coordinates 251
5.3 Linear Mappings 254
5.4 The Vector Space of Linear Mappings 271
5.5 Multiplication of Linear Mappings, and Inverses 273
5.6 Matrix Representations of Linear Mappings 284
5.7 Coordinates and Matrix Representation in a New Basis 293
5.8 Applications 299
5.9 Exercises 306

Chapter 6. Eigenvalues, Invariant Subspaces, Canonical Forms 313
6.1 Introduction 313
6.2 Basic Concepts 313
6.3 Matrix Polynomials 325
6.4 The Construction of Invariant Subspaces 336
6.5 Diagonal and Triangular Forms 341
6.6 The Jordan Canonical Form 351
6.7 Complexification 360
6.8 Applications 361
6.9. Exercises 378

Chapter 7. Special Matrices 383
7.1 Introduction 383
7.2 Diagonal, Tridiagonal, and Triangular Matrices 383
7.3 Idempotent and Nilpotent Matrices 393
7.4 Matrices in Inner Product Spaces 396
7.5 Definite Matrices 410
7.6 Nonnegative Matrices 418

7.7 Applications......437
7.8 Exercises......450

Chapter 8. Elements of Matrix Analysis......455
8.1 Introduction......455
8.2 Vector Norms......455
8.3 Matrix Norms......461
8.4 Applications......474
8.5 Exercises......491

References......495

Index......497