

Contents

Preface	i
1 Preliminaries	1
1.1 Notation and Definitions	1
1.2 Vector and Matrix Norms	4
1.3 Eigenvalues and Eigenvectors	6
1.4 The Singular Value Decomposition	10
1.5 Symmetric Matrices	11
1.6 Vandermonde Matrices	13
1.7 The Kronecker Product	16
1.8 The Implicit Function Theorem	18
1.9 The Derivative of a Simple Eigenvalue	22
Notes and References	32
2 Jacobi Matrix Inverse Eigenvalue Problems	35
2.1 Introduction	35
2.2 Preparation Theorems	37
2.3 Existence and Uniqueness	41
2.4 Sensitivity	45
2.5 Numerical Methods	51
2.5.1 Lanczos Method	51
2.5.2 Orthogonal Reduction Methods	55
2.6 Rank One Update Problem	68
2.7 Persymmetric Problem	70
2.8 Periodic Problem	73
2.9 Double Dimension Problem	80
2.10 Miscellaneous Problems	87
2.10.1 Banded Matrix Inverse Eigenvalue Problem	87
2.10.2 Rank One Modification Problem	90
2.10.3 Construction of a Jacobi Matrix from Its Eigenpairs	91
Notes and References	92
3 Pole Assignment Problems	95

3.1	Introduction	95
3.2	Controllability	97
3.3	Pole Assignment Theorem	102
3.4	Sensitivity Issues	106
3.4.1	The Single-input Case	107
3.4.2	The Multi-input Case	111
3.5	Schur Method	117
3.5.1	Preliminary Algorithms	118
3.5.2	Schur Algorithm	123
3.6	Invariant Subspace Method	128
3.6.1	Reduction to Orthogonal Canonical Form	128
3.6.2	The Basic Idea and Techniques	131
3.6.3	Invariant Subspace Algorithm	139
3.7	QR-like Method	141
3.7.1	Reduction to Staircase Canonical Form	142
3.7.2	The Basic Idea	144
3.7.3	The Techniques for Assigning Real Poles	146
3.7.4	The Techniques for Assigning Complex Poles	148
3.7.5	QR-like Algorithm	161
3.8	Numerical Examples	166
3.9	Robust Pole Assignment Problems	173
3.9.1	Measures of Robustness	173
3.9.2	Formulation I and Numerical Method I	177
3.9.3	Formulation II and Numerical Method II	185
	Notes and References	194
4	Additive and Multiplicative Inverse Eigenvalue Problems	197
4.1	Introduction	197
4.2	The Solvability of Two-dimensional Problems	201
4.3	Necessary Conditions for the Solvability	204
4.4	Sufficient Conditions for the Solvability	210
4.4.1	The Nonsymmetric Case	212
4.4.2	The Symmetric Case	219
4.5	Sensitivity Analysis	235
4.6	Newton-like Methods	243
4.6.1	Methods for Solving Problem SG	244
4.6.2	Methods for Solving Problem G	253
4.7	Homotopy Method	256
4.7.1	Homotopy Theory	256
4.7.2	Homotopy Algorithm	259
	Notes and References	261
5	Nonnegative Matrix Inverse Eigenvalue Problems	263
5.1	Introduction	263

5.2 Perron-Frobenius Theorem 264
5.3 The Smallest Realizable Spectral Radius 265
5.4 Symmetric Problem 272
Notes and References 279

Bibliography **281**

Index **299**