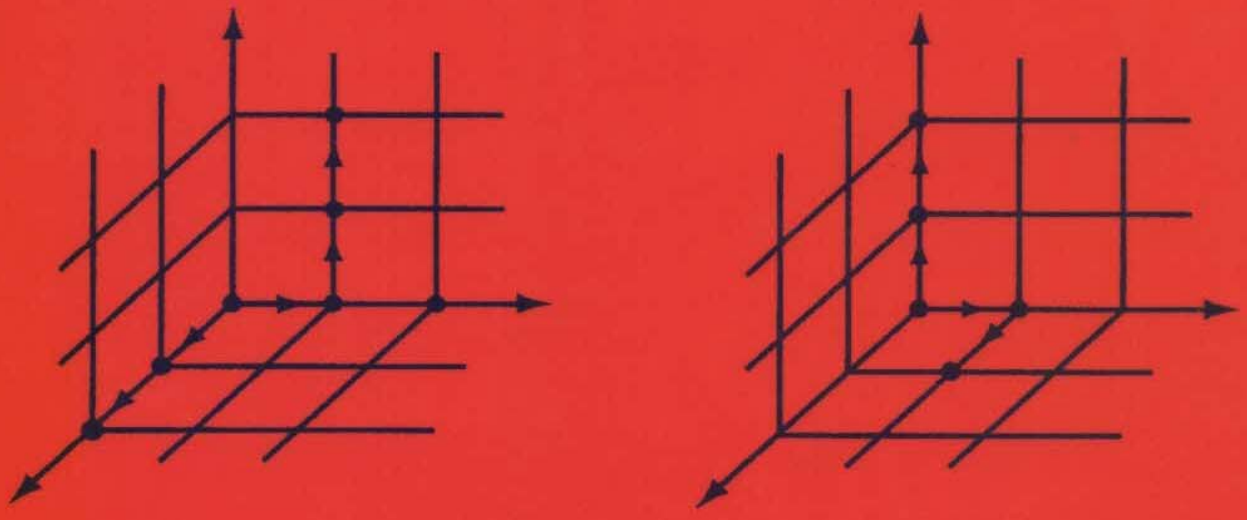
Lecture Notes in Control and Information Sciences 256

Eva Zerz

Topics in Multidimensional Linear Systems Theory



Springer

Table of Contents

1. Controllability of Multidimensional Systems 1
- 1.1 Preliminaries and Notation 2
  - 1.1.1 Gröbner Bases 2
  - 1.1.2 Elementary Algebraic Geometry 3
- 1.2 Primeness of Multivariate Polynomial Matrices 4
  - 1.2.1 Zero and Minor Primeness 5
  - 1.2.2 Factor Primeness 7
  - 1.2.3 Relations Between the Various Primeness Notions 11
  - 1.2.4 Module–theoretic Interpretation of Primeness 14
- 1.3 Controllability, Observability, and Autonomy 15
  - 1.3.1 Controllable–autonomous Decompositions 18
- 1.4 Controllability as Concatenability of Trajectories 22
  - 1.4.1 Previous Definitions of Controllability 22
  - 1.4.2 A New Definition of Controllability 26
  - 1.4.3 Behavioral and Classical Definitions 32
- 1.5 Controllability as Parameterizability 33
  - 1.5.1 The Parameterizability Criterion 33
  - 1.5.2 Examples 34

2. Co-prime Factorizations of Multivariate Rational Matrices 41
- 2.1 Notions 42
- 2.2 Characterizations of Primeness 44
- 2.3 Constructing Co-prime Factorizations 45
- 2.4 Properties of Co-prime Factorizations 47
- 2.5 Factorization Ideals 49
- 2.6 The Bivariate Case 52

3. Stabilizability 57
- 3.1 Co-primeness over Rings of Fractions 57
- 3.2 Feedback Stabilization 64

4. Strict System Equivalence 69
4.1 System Equivalence 71
4.2 Strict System Equivalence 73
4.3 System Isomorphisms 77

5. First Order Representations of Multidimensional Systems 85
5.1 Preliminaries and Notation 86
5.2 Output-nulling Representations 89
5.3 Driving-variable Representations 101

6. Linear Fractional Transformations 105
6.1 LFT Construction 108
6.2 Reduction to Trim Form 114
6.2.1 Further Transformations 118
6.3 Balancing 121
6.3.1 Balanced Truncation 125
6.4 LFTs and Robust Stability 127
6.4.1 Descriptor Systems 133
6.4.2 Example 137

7. Electrical Networks 141
7.1 Graph Theory 141
7.2 Weight Functions 142
7.3 Kirchhoff's Laws 143
7.4 Linear Networks 145
7.5 LFT Representations 150

Bibliography 157

Index 163