Contents

Preface

1 Introduction 
   1. Systems under Consideration  1
   2. What Is Observability?  2
   3. Summary of the Book  2
   4. The New Observability Theory Versus the Old Ones  3
   5. A Word about Prerequisites  4
   6. Comments  5

Part I. Observability and Observers

2 Observability Concepts  9
   1. Infinitesimal and Uniform Infinitesimal Observability  9
   2. The Canonical Flag of Distributions  11
   3. The Phase-Variable Representation  12
   4. Differential Observability and Strong Differential Observability  14
   5. The Trivial Foliation  15
   6. Appendix: Weak Controllability  19

3 The Case $d_y \leq d_u$  20
   1. Relation Between Observability and Infinitesimal Observability  20
   2. Normal Form for a Uniform Canonical Flag  22
   3. Characterization of Uniform Infinitesimal Observability  24
   4. Complements  26
   5. Proof of Theorem 3.2  29
## Contents

### Part I. The Case \( d_y > d_u \)

1. Definitions and Notations 37
2. Statement of Our Differential Observability Results 40
3. Proof of the Observability Theorems 42
4. Equivalence between Observability and Observability for Smooth Inputs 51
5. The Approximation Theorem 57
6. Complements 58
7. Appendix 59

### Part II. Singular State-Output Mappings

1. Assumptions and Definitions 68
2. The Ascending Chain Property 71
3. The Key Lemma 73
4. The \( ACP(N) \) in the Controlled Case 78
5. Globalization 81
6. The Controllable Case 84

### Observers: The High-Gain Construction

1. Definition of Observer Systems and Comments 87
2. The High-Gain Construction 95
3. Appendix 120

### Part II. Dynamic Output Stabilization and Applications

7. Dynamic Output Stabilization 125
1. The Case of a Uniform Canonical Flag 126
2. The General Case of a Phase-Variable Representation 132
3. Complements 141

8. Applications 143
1. Binary Distillation Columns 143
2. Polymerization Reactors 163

### Appendix

179

---

**Solutions to Part I Exercises** 195

**Bibliography** 217

**Index of Main Notations** 221

**Index** 224