

CONTENTS

VOLUME XII

Control of Nonlinear Systems	1
<i>Hassan K. Khalil, Department of Electrical and Computer Engineering, Michigan State University, East Lansing, MI 48824-1226, USA</i>	

1. Introduction
2. Stability
 - 2.1. Lyapunov Stability
 - 2.2. Input-Output Stability
 - 2.3. Passivity
 - 2.4. Feedback Systems
3. Sensitivity Analysis and Asymptotic Methods
4. Linearization and Gain Scheduling
5. Nonlinear Geometric Methods
6. Feedback Linearization
7. Robust Control
8. Nonlinear Design
9. Output Feedback Control
10. Nonlinear Output Regulation
11. Further Reading

Analysis of Nonlinear Control Systems	24
<i>Hassan K. Khalil, Department of Electrical and Computer Engineering, Michigan State University, USA.</i>	

1. Introduction
2. Fundamental Properties
3. Sensitivity Analysis
4. The Small-gain Theorem
5. Passivity Theorems
6. Averaging
7. Singular Perturbations
8. Further Reading

Lie Bracket	42
<i>Kurt Schlacher, Department for Automatic Control and Control Systems Technology, Johannes Kepler University Linz, Austria</i>	

1. Introduction
2. Basics of Manifolds and Bundles
 - 2.1. Manifolds
 - 2.1.1. Fibered Manifolds and Bundles
 - 2.2. Flow, Tangent Vectors and Tangent Bundle
3. Lie Derivatives and the Lie Bracket
4. Distributions and the Theorem of Frobenius
5. A Short Example
6. Concluding Remarks

Differential Geometric Approach and Application of Computer Algebra	63
<i>Kurt Schlacher, Department for Automatic Control and Control Systems Technology, Johannes Kepler University Linz, Austria</i>	

1. Introduction
2. Remarks on Symbolic Computation
3. Some Mathematical Facts
 - 3.1. Jet Manifolds
 - 3.2. An Algebraic Picture of Submanifolds
 - 3.3. Formal Integrability of Differential Equations
 - 3.4. The Theorems of Frobenius
4. Equivalence Problems
5. Some Applications
 - 5.1. Accessibility
 - 5.2. Observability
 - 5.3. Input to State Linearization
 - 5.4. Descriptor Systems
6. Concluding Remarks

Volterra and Fliess Series Expansion**92**Francoise Lamnabhi-Lagarigue, *Laboratoire des Signaux et Systèmes, CNRS, Supelec, France*

1. Introduction
2. Functional representation of nonlinear systems
 - 2.1. Volterra Functional Series
 - 2.2. On the Convergence of Volterra Series
3. Recursive computation of the kernels.
 - 3.1. Exponential Input Method
 - 3.2. Differential Geometry Approach
 - 3.3. Algebraic Approach
 - 3.4. Links between Volterra and Fliess Series
 - 3.5. Efficient Computation of Volterra Kernels
4. Computation of the response to typical inputs
 - 4.1. Transfer Function Approach: Association of Variables
 - 4.2. Algebraic Approach

Lyapunov Stability**115**Hassan K. Khalil, *Department of Electrical and Computer Engineering, Michigan State University, USA.*

1. Introduction
2. Autonomous Systems
3. The Invariance Principle
4. Linear Systems
5. Linearization
6. Non-autonomous Systems
7. Further Reading

Input-output Stability**128**Stephen P. Banks, *Department of Automatic Control and Systems Engineering, University of Sheffield, Sheffield S1 3JD, UK.*

1. Introduction
2. Signals and Norms
3. Systems and Gains
4. The Circle Theorem
5. Passivity
6. Interconnected Systems, Graphs and Robustness
7. Conclusions and Further Developments

Controllability and Observability of Nonlinear Systems 145

Henri Huijberts, *Department of Engineering, Queen Mary University of London, , United Kingdom*
 Henk Nijmeijer, *Department of Mechanical Engineering, Eindhoven University of Technology, , The Netherlands*

1. Introduction
2. Preliminaries
3. Controllability and accessibility
 - 3.1. Controllability and Linearization
 - 3.2. Driftless Systems
 - 3.3. Systems with Drift
4. Observability

Design for Nonlinear Control Systems 167

Alberto Isidori, *Dipartimento di Informatica e Sistemistica, Università di Roma "La Sapienza" and Department of Systems Science and Mathematics, Washington University in St. Louis, Italy*

1. Introduction
2. State-feedback design for global stability
3. State-feedback design for robust global stability
4. Semiglobal and practical stabilization
5. Output-feedback design
6. Conclusions

Feedback Linearization of Nonlinear Systems 193

Alberto Isidori, *Dipartimento di Informatica e Sistemistica, Università di Roma "La Sapienza" and Department of Systems Science and Mathematics, Washington University in St. Louis, Italy*
 Claudio De Persis, *Dipartimento di Informatica e Sistemistica, Università di Roma "La Sapienza", Italy.*

1. The problem of feedback linearization
2. Normal forms of single-input single-output systems
3. Conditions for exact linearization via feedback

Index 215**About EOLSS** 219