Contents

1 Amplitude Death, Synchrony, and Chimera States in Delay Coupled Limit Cycle Oscillators 1
Abhijit Sen, Ramana Dodla, George L. Johnston, and Gautam C. Sethia
1.1 Introduction 1
1.2 A Minimal Collective Model 3
1.2.1 Time delay effects 6
1.3 *N*-Oscillator Models 15
1.3.1 Global Coupling 16
1.3.2 Nearest Neighbor Coupling 18
1.3.3 Non-Local Coupling 26
1.4 Summary and Perspectives 40
References 41

2 Delay-Induced Stability: From Oscillators to Networks 45
Fatihcan M. Atay
2.1 Introduction 45
2.2 A Brief Synopsis of Averaging Theory 46
2.3 Stability by Delayed Feedback 48
2.4 Amplitude Death in Networks of Oscillators 52
2.5 Diffusively Coupled Networks 55
2.6 Discrete-Time Systems 58
2.7 Concluding Remarks 60
References 61

3 Delay Effects on Output Feedback Control of Dynamical Systems 63
Silviu-Iulian Niculescu, Wim Michiels, Keqin Gu, and Chaouki T. Abdallah
3.1 Introduction 63
3.1.1 Existing Methodologies 64
3.1.2 Problem Formulation and Related Remarks 66
3.1.3 Methodology and Approach 67

Bibliografische Informationen
http://d-nb.info/997432314

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

3.2 Main Results 67
3.2.1 Notation 67
3.2.2 Stabilizability in the Delay Parameter 70
3.2.3 Controller Design 75
3.3 Illustrative Examples 76
3.3.1 Second-Order System 77
3.3.2 Stabilizing a Chain of Oscillators 78
3.3.3 Multiple Crossing Frequencies Toward (in)Stability 80
3.4 Concluding Remarks 82
References 83

4 Time-Delayed Feedback Control: From Simple Models to Lasers and Neural Systems 85
Eckehard Schöll, Philipp Hövel, Valentin Flunkert, and Markus A. Dahlem
4.1 Introduction 85
4.2 Time-Delayed Feedback Control of Generic Systems 87
4.2.1 Stabilization of Unstable Steady States 87
4.2.2 Asymptotic Properties 100
4.2.3 Beyond the Odd Number Limitation of Unstable Periodic Orbits 107
4.2.4 Stabilizing Periodic Orbits Near a Fold Bifurcation 116
4.3 Time-Delayed Control of Optical Systems 122
4.3.1 Stabilizing Continuous-Wave Laser Emission by Phase-Dependent Coupling 123
4.3.2 Noise Suppression by Time-Delayed Feedback 125
4.4 Time-Delayed Control of Neuronal Dynamics 130
4.4.1 Model of Two Coupled Neurons 131
4.4.2 Control of Stochastic Synchronization 133
4.4.3 Dynamics of Delay-Coupled Neurons 136
4.4.4 Delayed Self-Feedback and Delayed Coupling 140
References 144

5 Finite Propagation Speeds in Spatially Extended Systems 151
Axel Hutt
5.1 Introduction 151
5.2 Dynamics in the Absence of Noise 152
5.2.1 A Neural Field Model 152
5.2.2 The Generic Model 158
5.3 Dynamics In The Presence of Noise 168
5.3.1 General Stability Study 168
5.3.2 Application to a Specific Model 171
References 175

6 Stochastic Delay-Differential Equations 177
André Longtin
6.1 Introduction 177
6.2 The Fundamental Issue 178
6.3 Linear SDDEs 180
6.4 Small Delay Expansion 181
6.5 Reduction Techniques 184
6.5.1 Reducing the Dimensionality 184
6.5.2 Crossing Time Problems 187
6.6 Stochastic Delayed Neurodynamics 188
6.6.1 Neural Noise and Delays 188
6.6.2 Neural Control 189
6.6.3 Neural Population Dynamics 189
6.6.4 Simplified Stochastic Spiking Model with Delay 191
6.7 Conclusion 192
References 193

7 Global Convergent Dynamics of Delayed Neural Networks 197
Wenlian Lu and Tianping Chen
7.1 Introduction 197
7.2 Stability of Delayed Neural Networks 201
7.2.1 Preliminaries 201
7.2.2 Delayed Hopfield Neural Networks 204
7.2.3 Delayed Cohen–Grossberg Competitive and Cooperative Networks 209
7.3 Periodicity and Almost Periodicity of Delayed Neural Networks 217
7.3.1 Delayed Periodic Hopfield Neural Networks 218
7.3.2 Delayed Periodic Cohen–Grossberg Competitive and Cooperative Neural Networks 221
7.3.3 Delayed Almost Periodic Hopfield Neural Networks 226
7.4 Delayed Neural Network with Discontinuous Activations 232
7.4.1 Preliminaries 234
7.4.2 Stability of Equilibrium 241
7.4.3 Convergence of Periodic and Almost Periodic Orbits 245
7.5 Review and Comparison of Literature 252
References 258

8 Stability and Hopf Bifurcation for a First-Order Delay Differential Equation with Distributed Delay 263
Fabien Crauste
8.1 Introduction 263
8.2 Definitions and Hopf Bifurcation Theorem 265
8.3 State of the Art and Objectives 269
8.3.1 The Classical Linear Discrete Delay Differential Equation 269

8.3.2 Known Results About Stability of Distributed Delay Differential Equations 273
8.4 Stability Analysis and Hopf Bifurcation for a Delay Differential Equation with Distributed Delay 276
8.5 Application: Periodic Oscillations in a Stem Cell Population 288
References 295

9 Deterministic Time-Delayed Traffic Flow Models: A Survey 297
Rifat Sipahi and Silviu-Iulian Niculescu
9.1 Introduction to Traffic Flow Problem 298
9.2 Classification of Traffic Models 299
9.2.1 Macroscopic Models 300
9.2.2 Microscopic Models 300
9.2.3 Mesoscopic Models 301
9.3 Empirical and Simulation Studies 301
9.3.1 Experimental Studies 301
9.3.2 Software Development 303
9.4 Time-Delay Effects in Traffic Flow Models 304
9.4.1 What is the Origin of Time Delay? 304
9.4.2 What is the Measure of Time Delay? 306
9.4.3 Development of Time-Delayed Traffic Models 308
9.5 Assumptions and Analysis on Mathematical Models 312
9.6 Interesting Research Topics 312
9.6.1 Linear Analysis with a Single Delay 313
9.6.2 Multiple Delays 314
9.6.3 Time-Varying Delays 316
9.6.4 Improved Traffic Stability with Multiple Vehicle Following 316
9.6.5 Multiple Vehicle Following Under Multiple Delays 316
9.6.6 Nonlinear Time-Delayed Traffic Dynamics 317
9.6.7 Optimal Velocity Model with Time Delay and Stochastic Process 317
9.6.8 Effects of Drivers' Memory 317
9.7 Conclusion and Discussion 318
References 319

Index 323