Contents

1. Introduction 1
1.1 History of Fuzzy Systems 1
1.2 T-S Fuzzy Systems 2
1.3 The Book 5

2. Stability Analysis of T-S Fuzzy Systems 9
2.1 Introduction 9
2.2 Problem Formulation 10
2.3 Stability Analysis 11
2.4 Augmented Fuzzy Weighting-Dependent Lyapunov-Krasovskii Functional Method 17
2.5 Further Augmented Lyapunov-Krasovskii Functional Methods 18
2.6 Illustrative Examples 22
2.7 Conclusions and Notes 25

3. Extension to Fuzzy Large-Scale Systems 27
3.1 Introduction 27
3.2 Problem Formulation 28
3.3 Stability Results 29
3.4 Illustrative Example 36
3.5 Conclusion 37

4. Stabilization Methods for T-S Fuzzy Systems 39
4.1 Problem Formulation 39
4.2 Stabilization Method Using Razumikhin Theorem 40
4.3 Other Stabilization Methods 45
4.3.1 Fuzzy Weighting-Dependent Approach 45
4.3.2 Using Updated Bounding Methods 45
4.3.3 Choosing Appropriate Functionals 47
4.4 Illustrative Examples 49
4.5 Conclusion 53

5. Variable Structure Control for T-S Fuzzy Systems 55
5.1 Introduction 55
5.2 Problem Formulation 56
5.3 Stabilization Results 57
5.3.1 Matched Uncertainty Case 57
5.3.2 Mismatched Uncertainty Case 62
5.4 Illustrative Example 67
5.5 Conclusion 71

6. Observer-Based Fuzzy Control: Delay-Independent Method 75
6.1 Introduction 75
6.2 Problem Formulation 76
6.3 Delay-Free Case 78
6.3.1 Two-Step LMI Method 78
6.3.2 Single-Step LMI Method 80
6.4 Time-Delay Case 85
6.4.1 Bounded Real Lemma 86
6.4.2 Main Results 89
6.5 Illustrative Examples 96
6.6 Conclusion and Notes 99

7. Observer-Based Fuzzy Control: Delay-Dependent Method 105
7.1 Introduction 105
7.2 Problem Formulation and Preliminaries 106
7.3 Main Result 108
7.4 Illustrative Examples 119
7.5 Conclusion 122

8. Output Tracking Control for T-S Fuzzy Systems 125
8.1 Introduction 125
8.2 Problem Formulation and Preliminaries 126
8.3 H_∞ Output Tracking Control Design for Delay-Free Systems 129
8.4 H_∞ Output Tracking Control Design for Time-Delay Systems 133
8.5 Illustrative Examples 139
8.6 Conclusion and Notes 143

9. Fuzzy Filter Design for T-S Fuzzy Systems 149
9.1 Introduction 149
9.2 Fuzzy Weighting-Dependent Approach to Filter Design 150

9.2.1 Problem Formulation 150
9.2.2 Main Results 152
9.3 General Fuzzy Filter Design 158
9.3.1 Problem Formulation 158
9.3.2 Main Results 160
9.4 Illustrative Examples 167
9.5 Conclusion 171

10. Descriptor Method for T-S Fuzzy Control Systems 173
10.1 Introduction 173
10.2 Fuzzy Descriptor Systems 174
10.3 Stability Result 176
10.4 Fuzzy Controller Design 180
10.5 Illustrative Examples 183
10.6 Conclusion and Notes 188

Appendix A 189

Appendix B 191

References 193

Index 203