
Contents

1	Markov Jump Linear Systems	1
1.1	Introduction	1
1.2	Some Examples	4
1.3	Problems Considered in this Book	8
1.4	Some Motivating Remarks	11
1.5	A Few Words On Our Approach	12
1.6	Historical Remarks	13
2	Background Material	15
2.1	Some Basics	15
2.2	Auxiliary Results	18
2.3	Probabilistic Space	20
2.4	Linear System Theory	21
2.4.1	Stability and the Lyapunov Equation	21
2.4.2	Controllability and Observability	23
2.4.3	The Algebraic Riccati Equation and the Linear- Quadratic Regulator	26
2.5	Linear Matrix Inequalities	27
3	On Stability	29
3.1	Outline of the Chapter	29
3.2	Main Operators	30
3.3	MSS: The Homogeneous Case	36
3.3.1	Main Result	36
3.3.2	Examples	37
3.3.3	Proof of Theorem 3.9	41
3.3.4	Easy to Check Conditions for Mean Square Stability	45
3.4	MSS: The Non-homogeneous Case	48
3.4.1	Main Results	48
3.4.2	Wide Sense Stationary Input Sequence	49
3.4.3	The ℓ_2 -disturbance Case	55

3.5	Mean Square Stabilizability and Detectability	57
3.5.1	Definitions and Tests	57
3.5.2	Stabilizability with Markov Parameter Partially Known	59
3.6	Stability With Probability One	63
3.6.1	Main Results	63
3.6.2	An Application of Almost Sure Convergence Results ...	66
3.7	Historical Remarks	69
4	Optimal Control	71
4.1	Outline of the Chapter	71
4.2	The Finite Horizon Quadratic Optimal Control Problem	72
4.2.1	Problem Statement	72
4.2.2	The Optimal Control Law	74
4.3	Infinite Horizon Quadratic Optimal Control Problems	78
4.3.1	Definition of the Problems	78
4.3.2	The Markov Jump Linear Quadratic Regulator Problem	80
4.3.3	The Long Run Average Cost	81
4.4	The H_2 -control Problem	82
4.4.1	Preliminaries and the H_2 -norm	82
4.4.2	The H_2 -norm and the Grammians	83
4.4.3	An Alternative Definition for the H_2 -control Problem	86
4.4.4	Connection Between the CARE and the H_2 -control Problem	86
4.5	Quadratic Control with Stochastic ℓ_2 -input	90
4.5.1	Preliminaries	90
4.5.2	Auxiliary Result	91
4.5.3	The Optimal Control Law	94
4.5.4	An Application to a Failure Prone Manufacturing System	96
4.6	Historical Remarks	99
5	Filtering	101
5.1	Outline of the Chapter	101
5.2	Finite Horizon Filtering with $\theta(k)$ Known	102
5.3	Infinite Horizon Filtering with $\theta(k)$ Known	109
5.4	Optimal Linear Filter with $\theta(k)$ Unknown	113
5.4.1	Preliminaries	113
5.4.2	Optimal Linear Filter	114
5.4.3	Stationary Linear Filter	117
5.5	Robust Linear Filter with $\theta(k)$ Unknown	119
5.5.1	Preliminaries	119
5.5.2	Problem Formulation	119

5.5.3	LMI Formulation of the Filtering Problem	124
5.5.4	Robust Filter	127
5.6	Historical Remarks	128
6	Quadratic Optimal Control with Partial Information	131
6.1	Outline of the Chapter	131
6.2	Finite Horizon Case	132
6.2.1	Preliminaries	132
6.2.2	A Separation Principle	133
6.3	Infinite Horizon Case	136
6.3.1	Preliminaries	136
6.3.2	Definition of the H_2 -control Problem	137
6.3.3	A Separation Principle for the H_2 -control of MJLS	139
6.4	Historical Remarks	141
7	H_∞-Control	143
7.1	Outline of the Chapter	143
7.2	The MJLS H_∞ -like Control Problem	144
7.2.1	The General Problem	144
7.2.2	H_∞ Main Result	145
7.3	Proof of Theorem 7.3	148
7.3.1	Sufficient Condition	148
7.3.2	Necessary Condition	151
7.4	Recursive Algorithm for the H_∞ -control CARE	162
7.5	Historical Remarks	166
8	Design Techniques and Examples	167
8.1	Some Applications	167
8.1.1	Optimal Control for a Solar Thermal Receiver	167
8.1.2	Optimal Policy for the National Income with a Multiplier–Accelerator Model	169
8.1.3	Adding Noise to the Solar Thermal Receiver problem	171
8.2	Robust Control via LMI Approximations	173
8.2.1	Robust H_2 -control	174
8.2.2	Robust Mixed H_2/H_∞ -control	182
8.2.3	Robust H_∞ -control	187
8.3	Achieving Optimal H_∞ -control	188
8.3.1	Algorithm	188
8.3.2	H_∞ -control for the UarmII Manipulator	189
8.4	Examples of Linear Filtering with $\theta(k)$ Unknown	197
8.4.1	Stationary LMMSE Filter	198
8.4.2	Robust LMMSE Filter	199
8.5	Historical Remarks	201

A	Coupled Algebraic Riccati Equations	203
A.1	Duality Between the Control and Filtering CARE	203
A.2	Maximal Solution for the CARE	208
A.3	Stabilizing Solution for the CARE	216
A.3.1	Connection Between Maximal and Stabilizing Solutions	216
A.3.2	Conditions for the Existence of a Stabilizing Solution	217
A.4	Asymptotic Convergence	226
B	Auxiliary Results for the Linear Filtering Problem with $\theta(k)$ Unknown	229
B.1	Optimal Linear Filter	229
B.1.1	Proof of Theorem 5.9 and Lemma 5.11	229
B.1.2	Stationary Filter	232
B.2	Robust Filter	236
C	Auxiliary Results for the H_2-control Problem	249
	References	257
	Notation and Conventions	271
	Index	277

Discrete-Time Markov Jump Linear Systems
Costa, O.L.V.; Fragoso, M.D.; Marques, R.P.
2005, X, 286 p. 15 illus., Hardcover
ISBN: 978-1-85233-761-2