Contents

Introduction ix

Notation xi

CHAPTER 1
Input/Output Properties 1

1.1. An Example 1
1.2. Review of Linear Algebra 4
1.3. Linear Systems 8
1.4. Controllability and Observability 10
1.5. Minimality 13
1.6. Realizability 16
1.7. Notes and References 19

CHAPTER 2
The *LQ* Regulator 21

2.1. Stabilization 21
2.2. Properness 24
2.3. Optimal Control 28
2.4. The Riccati Equation 32
2.5. The Space $M(m, n, p)$ 35
2.6. Notes and References 41

CHAPTER 3
Brownian Motion 43

3.1. Preliminary Definitions 43
3.2. Stochastic Calculus 52
3.3. Cameron–Martin–Girsanov Formula 57
3.4. Notes and References 62

CHAPTER 4
Filtering 64

4.1. Filtering 64
4.2. Consistency 73
4.3. Shannon Information 77
4.4. Notes and References 82

CHAPTER 5
The Adaptive *LQ* Regulator 84

5.1. Introduction 84
5.2. Smooth Admissible Controls 87
5.3. Adaptive Stabilization 91
5.4. Optimal Control 94
5.5. Bellman Equation 98
5.6. Notes and References 102

APPENDIX
Solutions to Exercises 103

Index 127