



# CONTENTS

<b>PREFACE</b>	<b>vii</b>
<b>Chapter 1. Introduction</b>	
1.1 Historical Development of Automatic Control	1
1.2 Control Systems and Stochastics	6
1.3 Adaptive Control and Decision Theory	7
<b>Chapter 2. Mathematical Description of Random Processes</b>	
2.1 Introductory Remarks	12
2.2 Probability	13
2.3 Joint Probability	17
2.4 Conditional Probability	17
2.5 Bayes' Theorem	19
2.6 Probability Distribution and Probability Density Function	21
2.7 Joint Probability Distribution and Joint Probability Density Function	25
2.8 Conditional Probability Distribution and Conditional Probability Density Function	28
2.9 Statistical Parameters of Random Variables	31
2.10 Stochastic Processes	39
2.11 Stationary Random Processes	42
2.12 Ergodic Hypothesis and Time Averages	44
2.13 Stationary Gaussian Random Processes	46
<b>Chapter 3. Basic Concept of Statistical Decision Theory</b>	
3.1 Introductory Remarks	50
3.2 General Description of the Decision Situation	51
3.3 Signal Detection	55
3.4 Signal Extraction	56

## Chapter 4. Evaluation Functions and Solutions in Statistical Decision Theory

4.1	Introductory Remarks	58
4.2	Basic Assumptions	58
4.3	General Formulation of Evaluation Functions in Decision Problems	61
4.4	Solutions of Decision Problems by the Bayes Criterion	63
4.5	Solutions of Binary Detection Problems	64
4.6	The Neyman-Pearson Detection Rule	69

## Chapter 5. Statistical Decision Concept in Control Processes

5.1	Introductory Remarks	72
5.2	Decision Adaptive Control Systems under Preassigned Error Probabilities	78
5.3	Binary Decision Adaptive Control Systems Based on the Concept of the Sequential Test	80
5.4	Decision Adaptive Control Systems Based on the Neyman-Pearson Test	85
5.5	Ideal-Observer Decision-Making	88

## Chapter 6. Nonsequential Decision Approaches in Adaptive Control Systems

6.1	Introductory Remarks	91
6.2	Extension of the Binary Detection Concept to $N$ -ary Decision Problems	92
6.3	Derivation of the Bayesian System	95
6.4	Construction of a Decision System Subjected to Gaussian Random Noise	100
6.5	Decision-Making in System Identification	104
6.6	Decision-Making in System Identification with Gaussian Random Noise	108
6.7	Numerical Examples of Application of Decision Concept to Averaging Devices	117
6.8	Application of Decision Concept to Nondata Problems	128

## Chapter 7. Sequential Decision Approaches in Adaptive Control Systems

7.1	Introductory Remarks	133
7.2	An Average Risk of Sequential Decision Procedure	133
7.3	Derivation of Bayes Solution	135
7.4	Application of Sequential Decision-Making to Adaptive Control Systems	139
7.5	Operating Characteristic Function (OC Function) and Average Sample Number Function (ASN Function)	143

7.6	Average Amount of Observation Time	153
7.7	Numerical Example	154
7.8	Comparison of Sequential and Nonsequential Decision Procedures	156
<b>Chapter 8. Adaptive Adjustment of Parameters of Nonlinear Control Systems</b>		
8.1	Introductory Remarks	161
8.2	Application of Sequential Decision Rule	162
8.3	On-Off Relay Decision Control Systems	170
<b>Chapter 9. Some Future Problems in Applications of Statistical Decision Theory to Control Processes</b>		
9.1	Introductory Remarks	200
9.2	Filtering Problems with Statistical Decision Theory	201
9.3	Present Status and Future Problems	209
AUTHOR INDEX		213
SUBJECT INDEX		215