CONTENTS

Preface xi

Chapter 1 **Introduction** 1
1.1 Structure of Decision and Estimation Problems 1
1.2 Outline of the Book 4

Chapter 2 **Review of Probability Theory** 6
2.1 Discrete Probability Theory 6
2.2 Random Variables 8
2.3 Random Processes 14
2.4 Summary 16
2.5 Problems 16

Chapter 3 **Binary Decisions: Single Observation** 21
3.1 Maximum-Likelihood Decision Criterion 21
3.2 Neyman-Pearson Criterion 27
3.3 Probability-of-Error Criterion 38
3.4 Bayes Risk Criterion 44
3.5 Min-Max Criterion 47
3.6 Summary 53
3.7 Problems 53

Chapter 4 **Binary Decisions: Multiple Observations** 60
4.1 Vector Observations 60
4.2 The General Gaussian Problem 69
4.3 Waveform Observations and Additive Gaussian Noise 77
4.4 Summary 90
4.5 Problems 91

Chapter 5 **Multiple Decisions** 96
5.1 Multiple Decisions: Bayes Risk 96
5.2 Probability of Error: General Case 105
5.3 Probability of Error: Gaussian Case 110
5.4 Erasure Decision Problems 125
5.5 Summary 130
5.6 Problems 130

Chapter 6 **Sequential Decision Theory** 134
6.1 Binary Erasure Criteria 135
6.2 Sequential Bayes Tests 140
6.3 The Wald Sequential Test 146
6.4 Average Sample Number 151
6.5 Summary 155
6.6 Problems 156

Chapter 7 **Composite and Nonparametric Decision Theory** 159
7.1 Composite Decisions 159
7.2 Sign Test 166
7.3 Wilcoxon Test 169
7.4 Summary 174
7.5 Problems 174

Chapter 8 **Fundamentals of Estimation** 179
8.1 Maximum-Likelihood Method 180
8.2 Bayes Cost Method 182
8.3 Relationship of Estimators 192
8.4 Linear Minimum-Variance and Least-Squares Methods 195
8.5 Summary 206
8.6 Problems 207

Chapter 9 **Estimation with Gaussian Noise** 211
9.1 Linear Observations 211
9.2 Sequential Estimation 216
9.3 Nonlinear Estimation 219
9.4 Summary 224
9.5 Problems 224

Chapter 10 **Properties of Estimators** 227
10.1 Unbiased Estimators 227
10.2 Efficient Estimators 231
10.3 Asymptotic Properties 237
10.4 Sensitivity and Error Analysis 238
10.5 Summary 241
10.6 Problems 241

Chapter 11 **State Estimation** 243
11.1 Problem Statement 243
11.2 Kalman Filter 244
11.3 Summary 250
11.4 Problems 250

Appendix A **Table of Densities** 252
Table A.1 Uniform Density 252
Table A.2 Scalar Gaussian Density 253
Table A.3 Vector Gaussian Density 253
Table A.4 Exponential Density 254
Table A.5 Laplacian Density 254
Table A.6 Rayleigh Density 255
Table A.7 Bernoulli Density 255
Table A.8 Binomial Density 255
Table A.9 Poisson Density 256

Appendix B **Probability Tables** 257
Table B.1 Q Function 257
Table B.2 Cumulative Binomial Distribution 259
Table B.3 Wilcoxon-Test False-Alarm Probability 264

References 267

Index 269