

Contents

PREFACE

ix

Chapter 1

INTRODUCTION

1

- 1.1 Motivation 1
- 1.2 Probability Models 2
- 1.3 Sample Space 3
- 1.4 Events 6
- 1.5 Algebra of Events 7
- 1.6 Graphical Methods of Representing Events 11
- 1.7 Probability Axioms 14
- 1.8 Combinatorial Problems 20
- 1.9 Conditional Probability 23
- 1.10 Independence of Events 26
- 1.11 Bayes' Rule 33
- 1.12 Bernoulli Trials 41

Chapter 2

DISCRETE RANDOM VARIABLES

54

- 2.1 Introduction 54
- 2.2 Random Variables and Their Event Spaces 55
- 2.3 The Probability Mass Function 57
- 2.4 Distribution Functions 58
- 2.5 Special Discrete Distributions 62

- 2.6 Analysis of Program MAX 84
- 2.7 The Probability Generating Function 88
- 2.8 Discrete Random Vectors 92
- 2.9 Independent Random Variables 98

Chapter 3

CONTINUOUS RANDOM VARIABLES 109

- 3.1 Introduction 109
- 3.2 The Exponential Distribution 114
- 3.3 The Reliability, Failure Density, and Hazard Function 118
- 3.4 Some Important Distributions 125
- 3.5 Functions of a Random Variable 139
- 3.6 Jointly Distributed Random Variables 144
- 3.7 Order Statistics 148
- 3.8 Distribution of Sums 154
- 3.9 Functions of Normal Random Variables 170

Chapter 4

EXPECTATION 181

- 4.1 Introduction 181
- 4.2 Moments 185
- 4.3 Expectation of Functions of More Than One Random Variable 188
- 4.4 Transform Methods 196
- 4.5 Moments and Transforms of Some Important Distributions 205
- 4.6 Computation of Mean Time to Failure 215
- 4.7 Inequalities and Limit Theorems 223

Chapter 5

CONDITIONAL DISTRIBUTION AND CONDITIONAL EXPECTATION 232

- 5.1 Introduction 232
- 5.2 Mixture Distributions 239
- 5.3 Conditional Expectation 245
- 5.4 Imperfect Fault Coverage and Reliability 251
- 5.5 Random Sums 260

Chapter 6

STOCHASTIC PROCESSES 268

- 6.1 Introduction 268
- 6.2 Classification of Stochastic Processes 274
- 6.3 The Bernoulli Process 280

- 6.4 The Poisson Process 283
- 6.5 Renewal Processes 292
- 6.6 Availability Analysis 297
- 6.7 Random Incidence 302
- 6.8 Renewal Model of Program Behavior 305

*Chapter 7***DISCRETE-PARAMETER MARKOV CHAINS****309**

- 7.1 Introduction 309
- 7.2 Computation of n -step Transition Probabilities 311
- 7.3 State Classification and Limiting Distributions 317
- 7.4 Distribution of Times Between State Changes 325
- 7.5 Irreducible Finite Chains with Aperiodic States 326
- 7.6 The $M/G/1$ Queuing System 336
- 7.7 Discrete-Parameter Birth-Death Processes 344
- 7.8 Finite Markov Chains with Absorbing States:
Analysis of Program Execution Time 351

*Chapter 8***CONTINUOUS-PARAMETER MARKOV CHAINS****360**

- 8.1 Introduction 360
- 8.2 The Birth and Death Process 365
- 8.3 Other Special Cases of the Birth-Death Model 388
- 8.4 Non-Birth-Death Processes 393
- 8.5 Markov Chains with Absorbing States 400

*Chapter 9***NETWORKS OF QUEUES****411**

- 9.1 Introduction 411
- 9.2 Open Queuing Networks 416
- 9.3 Closed Queuing Networks 423
- 9.4 Nonexponential Service-Time Distributions
and Multiple Job Types 446
- 9.5 Non-Product-Form Networks 454
- 9.6 Summary 464

*Chapter 10***STATISTICAL INFERENCE****469**

- 10.1 Introduction 469
- 10.2 Parameter Estimation 471
- 10.3 Hypothesis Testing 507

| | |
|-------------------------------------------------------------------------------|----------------|
| <i>Chapter 11</i> REGRESSION, CORRELATION, AND ANALYSIS OF VARIANCE | 538 |
| 11.1 Introduction | 538 |
| 11.2 Least-Squares Curve Fitting | 543 |
| 11.3 The Coefficient of Determination | 546 |
| 11.4 Confidence Intervals in Linear Regression | 549 |
| 11.5 Correlation Analysis | 552 |
| 11.6 Simple Nonlinear Regression | 556 |
| 11.7 Higher-Dimensional Least-Squares Fit | 557 |
| 11.8 Analysis of Variance | 559 |
| <i>Appendix A</i> BIBLIOGRAPHY | 573 |
| <i>Appendix B</i> PROPERTIES OF DISTRIBUTIONS | 579 |
| <i>Appendix C</i> STATISTICAL TABLES | 582 |
| <i>Appendix D</i> LAPLACE TRANSFORMS | 602 |
| <i>Appendix E</i> PROGRAM ANALYSIS | 608 |
| AUTHOR INDEX | 611 |
| SUBJECT INDEX | 617 |