

Contents

Preface	xiii
---------	------

Chapter 1	Introduction to Probability	1
1.0	Basic Concepts of Probability	1
1.1	Definitions	4
1.2	Elementary Set Theory	6
1.3	Axiomatic Approach to the Theory of Probability	10
1.4	Discrete and Continuous Sample Spaces	11
1.5	Conditional Probability and Bayes' Theorem	12
1.6	Independence of Events	18
1.7	Bernoulli Trials	21
1.8	Chapter Summary	27
1.9	Problems	28
1.10	Computer Examples	33
Chapter 2	Random Variables	40
2.0	Introduction	40
2.1	Concept of a Random Variable	40
2.2	Cumulative Distribution Function	41
2.3	Probability Density Function	47

2.4	Basic Statistical Properties of a Random Variable and Expected Values	50
2.5	Moments	52
2.6	Examples of Different Distributions	56
2.7	Moment-Generating Functions and Characteristic Functions	68
2.8	Transformation of a Random Variable	71
2.9	Conditional Probability Density	81
2.10	Chapter Summary	85
2.11	Problems	87
2.12	Computer Examples	93
Chapter 3	Multiple Random Variables	105
3.0	Introduction	105
3.1	Joint Cumulative Distribution Function of two Random Variables	106
3.2	Joint Probability Density Function of two Random Variables	108
3.3	Statistical Properties of Jointly Distributed Random Variables: Joint Moments	112
3.4	Jointly Distributed Gaussian Random Variables	118
3.5	Functions of Gaussian Jointly Distributed Random variables	119
3.6	Conditional Probability Density	121
3.7	Probability Density Function of Sum of two Random Variables	124
3.8	Expected Value of Sums of Random Variables	136
3.9	Variance of Sum of Random Variables	136
3.10	Brief Introduction to Central Limit Theorem	138
3.11	Estimate of Population Mean, Expected Value, and Variance of Estimate	141
3.12	Estimate of Population Variance	145
3.13	Computer Generation of Uniform Random Variables	147
3.14	Computer Generation of Gaussian Distributed Random Variables using the Central Limit Theorem	148
3.15	Testing the Equivalence of a Probability Density Function of Experimental Data to a Theoretical Density Function	148
3.16	Chapter Summary	157
3.17	Problems	159
3.18	Computer Examples	163
Chapter 4	Multiple Random Variables	203
4.0	Random Processes: Basic Definitions	203
4.1	Basic Properties of Random Processes	207
4.2	Autocorrelation Function	212
4.3	The Cross-Correlation Function	225

4.4	Estimate of Autocorrelation Function of Sample Records of Limited Duration	228
4.5	Chapter Summary	232
4.6	Problems	235
4.7	Computer Examples	241
Chapter 5	Spectral Density	268
5.0	Introduction	268
5.1	Basic Definition of the Spectral Density of a Random Process	269
5.2	Properties	272
5.3	White Noise	274
5.4	Time Domain and Frequency Domain Correspondence	277
5.5	Estimate of the Autocorrelation Function of a Discrete Function of Time using Frequency Domain Techniques	277
5.6	Estimation of the Spectral Density of Records of Limited Duration	282
5.7	Cross-Spectral Density	307
5.8	Estimation of Cross-Spectral Density of Records of Limited Duration	311
5.9	Coherence	315
5.10	Chapter Summary	321
5.11	Problems	324
5.12	Computer Examples	327
Chapter 6	Linear Systems	439
6.0	Introduction	439
6.1	Properties	441
6.2	Random Inputs	441
6.3	Estimate of the Response of Linear Systems using Frequency Domain Techniques	448
6.4	Matched Filter	453
6.5	Chapter Summary	462
6.6	Problems	463
6.7	Computer Examples	469
Chapter 7	Applications	492
7.0	Introduction	492
7.1	Radar Systems	493
7.2	Communication Systems	497
7.3	Solid-State Electronics	503
7.4	Computer Engineering	504
7.5	Biomedical Systems	507

Appendix	Introduction of the Fast Fourier Transform	513
A.1	Introduction	513
A.2	Relationship Between the Continuous Fourier Transform (CFT) and the Discrete Fourier Transform (DFT)	514
A.3	The Inverse Discrete Fourier Transform (IDFT)	518
A.4	The FFT Algorithm, Computational Speed, and Effects of Zero Padding	518
A.5	Practical Aspects of the Use of the FFT Algorithm	525
	Bibliography	529
	Index	531