

# Contents

## Symbols and Abbreviations

PART	<b>GENERAL BACKGROUND</b> .....	3
CHAPTER 1	<b>Introduction to Signals</b> .....	3
	1-1. General Definition of "Signal".....	3
	1-2. Importance of Signals and Signal Conception in Applied Science and Engineering.....	4
CHAPTER 2	<b>General Properties of Signals</b> .....	7
	2-1. Representation of a Signal as a Time Function or Wave Form.....	7
	2-2. Approximations to Wave Forms.....	10
	2-3. Transform Representation of Signals.....	15
	2-4. Functional Parameters of Signals.....	18
	2-5. Information and Modulation.....	23
	2-6. Statistical Parameters of Signals.....	25
	2-7. Conclusions.....	36
	Problems.....	38
CHAPTER 3	<b>Particular Properties and Signal Classification</b> .....	41
	3-1. Sets, Properties, and Classifications.....	42
	3-2. Particular Signal Properties to be Considered.....	44
	3-3. Criteria for Signal Classification.....	48
	Problems.....	49
PART II	<b>DETAILED STUDY OF IMPORTANT CLASSES OF SIGNALS</b> .....	53
CHAPTER 4	<b>Periodic Signals</b> .....	55
	4-1. Definitions and Importance of Periodic Signals... ..	56
	4-2. Direct Current and Alternating Current as Important Special Cases.....	56
	4-3. Fourier Series as a Synthesis of D-C and A-C Components.....	59
	4-4. Fourier-Series Analysis.....	62
	4-5. Special Cases and Techniques for Handling Them.....	69
	4-6. The Frequency Spectra of Periodic Signals.....	73
	4-7. Signal Power and the Power Spectrum.....	74
	4-8. Complex Numbers and Complex Signal Representation.....	77
	4-9. The Complex Fourier Series.....	83
	Problems.....	88

## Contents

CHAPTER 5	<b>Aperiodic Signals</b> .....	93
	5-1. Time-Limited Signals and the Fourier Transform .....	93
	5-2. Related Physical Concepts .....	100
	5-3. The Laplace Transform .....	105
	5-4. Related Physical Concepts and Applications .....	112
	5-5. Concluding Remarks on Fourier and Laplace Transforms .....	117
	Problems .....	118
CHAPTER 6	<b>Almost-Periodic Signals</b> .....	122
	6-1. Definitions and General Discussion .....	123
	6-2. Related Physical Concepts .....	125
	6-3. Amplitude-Modulated Wave Forms .....	131
	Problems .....	132
CHAPTER 7	<b>Discrete Random Signals</b> .....	134
	7-1. Probability Theory of Discrete Random Variables .....	134
	7-2. Application to Discrete-Amplitude Signals .....	143
	7-3. Simultaneous Random Variables .....	147
	7-4. Information of the Discrete Random Source .....	150
	Problems .....	153
CHAPTER 8	<b>Continuous Random Signals</b> .....	157
	8-1. Probability Theory of Continuous Random Variables .....	157
	8-2. Application to Signals .....	161
	8-3. Further Developments in Random-Signal Theory .....	169
	8-4. Noise .....	175
	8-5. Information of the Continuous Random Source ..	178
	Problems .....	181
<b>PART III SIGNAL PROCESSES</b> .....		185
CHAPTER 9	<b>Introduction to Signal Processes</b> .....	187
	9-1. Terminology .....	187
	9-2. Signal Processes as Effects on Signal Parameters ..	188
	9-3. Amplification and Attenuation .....	188
	9-4. Rectification and Conversion .....	189
	9-5. Mixing and Filtering .....	190
	9-6. Setting of Average Level .....	190
	9-7. Miscellaneous Processes .....	191
	9-8. Measurements .....	192
	Problems .....	193
CHAPTER 10	<b>Linear Signal Processes</b> .....	195
	10-1. Basic Definitions and Properties .....	195
	10-2. Input-Output Relations in the Frequency Domain .....	197
	10-3. Frequency-Domain Analysis .....	200
	10-4. Time-Domain Analysis .....	205
	10-5. Amplification .....	210
	10-6. Linear Mixing .....	214
	10-7. Linear Filtering .....	215

## Contents

10-8. Concluding Remarks .....	217
Problems .....	217
<b>CHAPTER 11 Nonlinear Processes</b> .....	221
11-1. Basic Definitions and Consequences .....	221
11-2. Classification of Nonlinear processes .....	222
11-3. Smoothly Nonlinear, Nonreactive Processes .....	224
11-4. Abruptly Nonlinear, Nonreactive Processes .....	231
11-5. Reactive Processes .....	233
11-6. Concluding Remarks .....	234
Problems .....	235
<b>APPENDIX</b> .....	239
<b>Table of Laplace Transforms</b> .....	241
A. Operation Transform Pairs .....	241
B. Function Transform Pairs .....	242
C. Partial-Fraction Expansion Forms for Rational Fractions $F_s = P_s/Q_s$ .....	243
<b>BIBLIOGRAPHY</b> .....	245
<b>INDEX</b> .....	249