

Contents

Chapter 1 Representation of Signals and Systems

- 1.1 Fourier Series 2
- 1.2 Discrete Spectrum 5
- 1.3 Fourier Transform 9
- 1.4 Properties of The Fourier Transform 14
- 1.5 Continuous Spectrum 34
- 1.6 Time-Bandwidth Product 39
- 1.7 Fourier Transforms of Finite-Power Signals 44
- 1.8 Use of Delta Functions in Spectral Analysis 54
- 1.9 Numerical Computation of the Fourier Transform 59
- 1.10 Correlation 61
- 1.11 Transmission of Signals Through Linear Systems 66
- 1.12 Ideal Low-Pass Filters 78
- 1.13 Hilbert Transform 82
- 1.14 Pre-Envelope 88
- 1.15 Band-Pass Signals 89
- 1.16 Band-Pass Systems 93
- 1.17 Summary 103
- Problems 108

Chapter 2 Random Signals and Noise

- 2.1 Probability 136
- 2.2 Random Variables 140
- 2.3 Gaussian Distribution 152
- 2.4 Transformation of Random Variables 156
- 2.5 Random Processes 161
- 2.6 Stationarity 162
- 2.7 Correlation and Covariance Functions 163
- 2.8 Regularity and Ergodicity 171
- 2.9 Gaussian Process 173

xiv Contents

- 2.10 Transmission of a Random Process Through a Linear Filter 177
- 2.11 Spectral Density 178
- 2.12 Noise 194
- 2.13 Narrow-Band Noise 203
- 2.14 Envelope of Sine-Wave Plus Narrow-Band Noise 214
- 2.15 Summary 217
- Problems 220

Chapter 3 Amplitude Modulation Systems

- 3.1 Amplitude Modulation (AM) 244
- 3.2 Generation of AM Waves 250
- 3.3 Demodulation of AM Waves 254
- 3.4 Double-Sideband Suppressed-Carrier Modulation (DSBSC) 256
- 3.5 Generation of DSBSC Waves 258
- 3.6 Coherent Detection of DSBSC Waves 261
- 3.7 Single-Sideband Modulation (SSB) 267
- 3.8 Generation of SSB Waves 271
- 3.9 Demodulation of SSB Waves 276
- 3.10 Vestigial Sideband Modulation (VSB) 280
- 3.11 Comparison of Various Amplitude Modulation Systems 288
- 3.12 Frequency Translation 289
- 3.13 Frequency-Division Multiplexing (FDM) 292
- 3.14 Nonlinear Distortion 295
- 3.15 Summary 298
- Problems 300

Chapter 4 Angle Modulation Systems

- 4.1 Basic Definitions: Phase Modulation (PM) and Frequency Modulation (FM) 318
- 4.2 Single-Tone Frequency Modulation 321
- 4.3 Narrow-Band Frequency Modulation 323
- 4.4 Wide-Band Frequency Modulation 325
- 4.5 Multitone FM Waves 331
- 4.6 Transmission Bandwidth of FM Waves 333

- 4.7 Generation of FM Waves 336
- 4.8 Demodulation of FM Waves 342
- 4.9 Response of Linear Filters to FM Waves 357
- 4.10 Nonlinear Effects in FM Systems 361
- 4.11 Summary 363
- Problems 365

Chapter 5 Noise in CW Modulation Systems

- 5.1 AM Receivers 378
- 5.2 Signal-To-Noise Ratios (SNR) 381
- 5.3 Noise in DSBSC Systems Using Coherent Detection 382
- 5.4 Noise in SSB Systems Using Coherent Detection 386
- 5.5 Noise in AM Systems Using Envelope Detection 389
- 5.6 FM Receivers 394
- 5.7 Noise in FM Systems 396
- 5.8 FM Threshold Effect 403
- 5.9 Pre-emphasis and De-emphasis in FM 410
- 5.10 Comparison of Noise Performances and Bandwidth Requirements of CW Modulation Systems 414
- 5.11 Summary 416
- Problems 419

Chapter 6 Pulse Modulation Systems

- 6.1 Sampling 430
- 6.2 Time-Division Multiplexing (TDM) 437
- 6.3 Pulse-Amplitude Modulation (PAM) 438
- 6.4 Pulse-Time Modulation 445
- 6.5 Pulse-Code Modulation (PCM) 454
- 6.6 Bandwidth, Pulse Shaping, and Intersymbol Interference 465
- 6.7 Noise in PCM Systems 481
- 6.8 Information Capacity of a PCM System 492
- 6.9 Differential Pulse-Code Modulation (DPCM) 496
- 6.10 Delta Modulation (DM) 498
- 6.11 Comparison of PCM, DPCM, and DM 501
- 6.12 Summary 503
- Problems 506

xvi Contents

Chapter 7 Optimum Receivers

- 7.1 Formulation of the Optimum Receiver Problem 522
- 7.2 Maximization of Output Signal-to-Noise Ratio 523
- 7.3 Probabilistic Approach 526
- 7.4 Properties of Matched Filters 533
- 7.5 Approximations in Matched Filter Design 538
- 7.6 Detection of Signals With Random Phase 544
- 7.7 Maximum Likelihood Estimation 547
- 7.8 Reception of Binary Data Using Different Signaling Techniques 550
- 7.9 M-ary Data Transmission Systems 569
- 7.10 Comparison of Noise Performance of Various PSK and FSK Systems 574
- 7.11 Summary 578
Problems 580

Appendix 1 Schwarz's Inequality 594

Appendix 2 Error Function 596

Appendix 3 Noise Figure 599

Appendix 4 Bessel Functions 604

Glossary 609

Index 613

