

Modern Digital Communication Techniques (3-1-0)

Module 1: (12 hrs)

Deterministic & Random Signal Analysis

Bandpass & Lowpass Signals, Lowpass Equivalent of Bandpass Signals, Energy Considerations, Lowpass Equivalent of a Bandpass System. Vector Space Concepts, Signal Space Concepts, Orthogonal Expansions of Signals, Gram-Schmidt Procedure. Bounds on Tail Probabilities, Limit Theorems for Sum of Random Variables. Complex Random Vectors. WSS Random Process, Cyclostationary Random Process, Proper and Circular Random Process, Markov Chains. Sampling Theorem for Band-limited Random Process, The Karhunen-Loeve Expansion. Bandpass and Lowpass Random Processes. [Proakis & Salehi Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9]

Module 2: (18 hrs)

Digital Modulation Scheme

Representation of Digitally Modulated Signals, Memoryless Modulation Methods; Pulse Amplitude Modulation, Phase Modulation, Quadrature Amplitude Modulation, Multidimensional Signaling. Signaling Schemes With Memory; Continuous-Phase Frequency-Shift Keying, Continuous-Phase Modulation. Power Spectrum of Digitally Modulated Signals; Power Spectral Density of a Digitally Modulated Signal With Memory, Power Spectral Density of Linearly Modulated Signals, Power Spectral Density of Digitally Modulated Signals With Finite Memory, Power Spectral Density of Modulated Schemes With a Markov Structure, Power Spectral Density of CPFSK and CPM Signals. [Proakis & Salehi Sections 3.1, 3.2, 3.3, 3.4, 3.5]

Optimum Receivers for AWGN Channels

Waveform and Vector Channel Models; Optimum Detection for a General Vector Channel. Waveform and Vector AWGN Channels; Optimal Detection for the Vector AWGN Channel, Implementation of the Optimal Receiver for the AWGN Channels. Optimal Detection and Error Probability for ASK, PAM, PSK AND QAM Signaling. [Proakis & Salehi Sections 4.1-1, 4.2-1, 4.2-2, 4.3-1, 4.3-2, 4.3-3]

Carrier and Symbol Synchronization

Signal Parameter Estimation; The Likelihood Function, Carrier Recovery and Symbol Synchronization in Signal Demodulation. Carrier Phase Estimation; Maximum Likelihood Carrier Phase Estimation, The Phase-Locked Loop, Effect of Additive Noise in the Phase Estimate. Symbol Timing Estimation; Maximum Likelihood Timing Estimation. [Proakis & Salehi Sections 5.1-1, 5.1-2, 5.2-1, 5.2-2, 5.2-3]

Module 3: (15 hrs)

Digital Communication Through Band-Limited Channels

Characterization of Band-Limited Channels. Signal Design for Band-Limited Channels; Design of Band-Limited Signals for No Intersymbol Interference-The Nyquist Criterion, Optimum Maximum-Likelihood Receiver. [Proakis & Salehi Sections 9.1, 9.2-1, 9.3-1]

Multichannel and Multicarrier Systems

Multichannel Digital Communications in AWGN Channels; Binary Signals, M-ary Orthogonal Signals. Multicarrier Communications; Single Carrier versus Multicarrier Modulation, Capacity of a Nonideal Linear Filter Channel, OFDM, Modulation & Demodulation in an OFDM, An FFT Algorithm Implementation of an OFDM System. [Proakis & Salehi Sections 11.1, 11.2-1, 11.2-2, 11.2-3, 11.2-4, 11.2-5]

Spread Spectrum Signals for Digital Communication

Model of Spread spectrum Digital Communication System. Direct Sequence Spread Spectrum Signals; Error Rate Performance of the Decoder, Some Applications of DS Spread Spectrum Signals. Frequency-Hopped Spread-Spectrum Signals; Performance of FH Spread Spectrum Signals in an AWGN Channel, A CDMA System Based on FH Spread Spectrum Signals. [Proakis & Salehi Section 12.1]

Text Book

1. John G. Proakis and Masoud Salehi, *Digital Communication*, McGraw-Hill, 5th Edition

Reference Books

1. Simon Haykin, *Digital Communication*, Wiley
2. Tube & Schilling, *Principle of Communication*, PHI