TKE213201

Communication Systems

Sistem Komunikasi

BASIC INFORMATION

Course Credit	3 / 150 minutes per Week
Course Type	Required
Course Classification	Engineering Topics
Prerequisites	Fundamentals of Telecommunication; Data Communications and Networks

STUDENT AND LEARNING OUTCOMES

Covered Student Outcomes

Fundamental and Engineering Knowledge (KP.1) Development of Engineering Solution (KP.2)

Learning Outcomes

LO1 The students are able to analyze the principal work and performance of various analog and digital modulation techniques.

LO2 The studets able to understand the role of statistical measure to model signal as a random process.

LO3 The students are able to analyze the conversion of analog signals to digital signal in communications.

LO4 The students are able to analyze the impact of noise in communications signals as well as the approach to mitigate this impact.

LO5 The students are able to analyze the role of compression and encryption in communication.

COURSE DESCRIPTION

This course material is more analytical (mathematical) to analyze the performance of the basic techniques and methods that exist in telecommunication today. Some analytical bases are necessary, for example about the area of frequency and probability. Some of the materials studied are quite deeply eg about modulation (analogue and digital), digitization by PCM, and the influence of noise in communication. Compression techniques, encryption, and channel encoding are also introduced.

TOPICS

1. Introduction to Digital and Analog Communication

1.1 Digital and Analog Information Sources, Digital and Analog Waveform

1.2 Digital and Analog Communication

1.3 Introduction to Digital Communication Block (Overview on Source Coding, Modulation, Channel Coding, etc)

1.4 Objective of Communication System

1.5 Impairments and Constraint on Communication System Media

1.6 Advantages and Drawback of Digital Communication System

1.7. Introduction to Bandwidth, Bit Rate, Channel Capacity, Nyquist Rate and Shannon Theorem
Note: The Nyquist Rate Concept should have been introduced in Sampling Theory discussed in Signal and System.

2. Basis of Analytics

2.1 Short Review on Probability and Random Variable

2.2 Introduction to Random Process and Statistical Measure of Random Process

2.3 Autocovariance, Autocorrelation, Cross-covariance, Cross-correlation of Random Process

2.4 Stationary Processes

2.5 Correlation of Deterministic Signal

2.6 Energy and Power Signal

2.7 Relationship between Signal and Vector, Signal Space

2.8 Concept of Orthogonality

2.9 Review on Spectral Analysis: Spectrum, Periodicity, Fourier Series and Transform

2.10 Normalized Power

2.11 Power Spectral Density

3. Analog Modulation: Amplitude Modulation

3.1 Motivation for Modulation and Type of Modulation

3.2 Amplitude Modulation with Complex Exponential Carrier and its analysis from Frequency Domain Perspective

3.3 Amplitude Modulation with a Sinusoidal Carrier and its analysis from Frequency Domain Perspective

3.4 Amplitude Modulation: Double Sideband Full Carrier

3.5 Amplitude Modulation: Double Sideband Suppressed Carrier

3.6 Amplitude Modulation: Single Sideband

3.7 AM Demodulation: Envelope Detection and Synchronous Detection

3.8. Example of Application of Modulation: Frequency Division Multiplexing, Frequency Division Duplexing, etc

4. Analog Modulation: Frequency Modulation

4.1 Introduction to Frequency Modulation

4.2 Sinusoidal Frequency Modulation and FM Spectrum

4.3 Frequency Modulation for Arbitrary Modulating Signal

4.4 Narrowband and Wideband Frequency Modulation

5. Conversion of Analog into Digital Signals in Telecommunication

5.1 Overview of Analog to Digital Conversion Block Diagram

5.2 Analytical Model for ADC-Pulse Code Modulation

5.3 Review on Sampling Theory (see Signal and System Course)

5.4 Quantization Process: Uniform Quantization and Quantization Noise

5.5 Encoding

5.6 Pulse Code Modulation: Compressing and Expanding

5.7 Delta Modulation

5.8 Overview on Speech Coding Techniques

5.9 Preview on Impact of Noise in Digital Communication

5.10 Implementation Aspect

6. Digital Modulation

6.1 Binary Modulation (BPSK, BASK, BFSK): Throughput and Reliability with respect to Noise
6.2 Bandwidth Conservation Technique: Modulation Technique, Modulation Alphabets, Pulse Shaping Filter
6.3 M-ary Modulation (QPSK, MPSK, QAM, MSK): Throughput and Reliability with respect to Noise
6.4 Implementation Aspect: PAPR and Constellation Diagram

7. Noise

7.1 Additive White Gaussian Noise
7.2 Noise Representation and Modeling
7.3 System Noise Calculation

8. The Impact of Noise on Analog Modulated Signal

8.1 The Impact of Noise on Amplitude Modulated Signal
8.2 The Impact of Noise on Frequency Modulated Signal

9. The Impact of Noise on Digital Communication

9.1 Match Filter
9.2 Bit Error Probability Analysis on Binary System
9.3 Bit Error Probability Analysis on M-ary System
9.4 SNR Analysis on PCM

10. Introduction to Information Theory and Error Control

10.1 Information and Entropy
10.2 Huffman Code
10.3 Encryption: Symmetric and Asymmetric Key
10.4 Error Detection: Parity and CRC
10.5 Error Correction: Block Codes, Convolutional Code, Turbo Code
10.6 Interleaving

REFERENCES

[1] Digital and Analog Communication Systems, Leon W. Couch, II, 8th Edition, Pearson Education Inc, 2013.
[2] Principles of Communication Systems , H. Taub and D.L Schilling, 2nd Edition, Mc Graw-Hill Book Company, 1986.
[3] Dasar-Dasar Telekomunikasi, B. Setiyanto, Penerbit Sakti, 2010
[4] Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, & S. Hamid Nawab, 2nd Edition, Prentice Hall, 1997.
[5] Digital Communication, J. G. Proakis & M. Salehi, 5 th Edition, Mc Graw Hill, 2008