TKB212202

Biomedical Signal Processing

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BASIC INFORMATION

Course Credit	3 / 150 minutes per Week
Course Type	Required
Course Classification	Engineering Topics
Prerequisites	Signals and Systems; Differential Equations; Complex Variable Analysis; Linear Algebra

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 apply Z-Transform and to identify the characteristic of a discrete-time linear system including its stability, frequency response, causailty and other important properties.

LO2 The students are able to analyze the frequency response of discrete-time system.

LO3 The students are able to understand the concept discrete time Fourier transform as well implement it in the form of fast Fourier transform.

LO4 The students are able to design digital FIR and IIR filter and understand its properties.

COURSE DESCRIPTION

In this course, the students study about the characterization of discrete-time signal and system using Z-transform, discrete-time Fourier transform and discrete Fourier transform. The students also learn the implementation of discrete Fourier transform in the form of fast Fourier transform algorithm and design a digital FIR and IIR filter.

TOPICS

1. Review on Discrete Time LTI System and Signals

1.1 Discrete Time Signal and Review on Sampling Theory

1.2 Discrete Time System and Block Diagram Representation

1.3 Discrete Time LTI System, Convolution, FIR and IIR System

1.4 Representation of Discrete Time LTI System using Difference Equation

1.5 Implementation of Discrete Time LTI System

1.6 Correlation of Discrete Time Signal

2. Z-Transform (First Part)

2.1 Review of Discrete Time Fourier Transform (DTFT)

2.2 Introduction to Z Transform and its relationship with DTFT

2.3 Direct Z-Transform

2.4 Region on Convergence

2.5 Property of Region of Convergence

2.6 Rational Function Z Transform

2.7 The use of Pole and Zero Concept to analyze Discrete-Time LTI System and Signal

3. Z-Transform (Second Part)

3.1 Inverse Z-Transform (Contour Integration, Power Series Expansion, Partial Fraction Expansion)

3.2 Properties of Z-Transform

3.3 Analysis of LTI System using Z-Transform (Causality and Stability Analysis, Transient and Steady State Response)

3.4 Design of Discrete-Time LTI System from Z-Transform Point of View

3.5 Unilateral (One-Sided) Z-Transform

4. Analysis of Discrete-Time LTI System in the Frequency Domain

4.1 Frequency Response of Discrete-Time LTI System

4.2 Signal Distortion (Magnitude and Phase Distortion, Group Delay)

4.3 Ideal Filter and Practical Filter

4.4 Relationship between Magnitude and Phase Response, Frequency Response of Rational LTI System Function

4.5 All-Pass Filter and Minimum Phase Filter

5. Discrete Fourier Transform (DFT)

5.1 Review of DTFT and its relationship with DFT: Frequency Domain Sampling and Reconstruction of Discrete-Time Signal

5.2 DFT Formulation

5.3 Properties of DFT: Periodicity, Linearity, Symmetry etc.

5.4 Multiplication Property and Circular Convolution

5.5 Analysis of Filtering Process using DFT

5.6 Analysis of Signal Frequency using DFT

5.7 Windowing and Zero Padding

6. Implementation of DFT using Fast Fourier Transform (FFT) Algorithm

6.1 Direct DFT Computation

6.2 Divide and Conquer Approach

6.3 FFT Radix-2 Algorithm

6.4 FFT Radix-4 Algorithm

6.5 Split-Radix FFT Algorithm

6.6 Implementation of FFT

6.7 Application of FFT

7. Structure of Digital Filter

7.1 Structure of FIR Filter (Direct-Form, Cascade-Form, Frequency-Sampling, and Lattice)

7.2 Structure of IIR Filter (Direct-Form, Signal Flow Graph and Transpose, Cascade-Form, Parallel-Form, Lattice, and Lattice-Ladder)

8. Digital Filter Design

8.1 Design of FIR Filter

8.2 Design of IIR Filter

REFERENCES

[1] Proakis, J.G., Manolakis, D.G., Dimitris G., Applied Digital Signal Processing : Theory and Practice, Cambridge University Press 2011

[2] Digital Signal Processing, J.G Proakis and D. Manolakis, 4th edition, 2007, Pearson

[3] Introduction to Digital Signal Processing, R. Kuc, 1988, Mc Graw Hill

[4] Discrete-Time Signal Processing, A.V. Oppenheim and R. Schaffer, 3th edition, 2009, Pearson