CSE 402: DIGITAL SIGNAL PROCESSING

Credit Hours: 3

Contact Hours: 3  
Grading:  As per UET Rules

1. COURSE OUTLINE

This course introduces students with the digital processing of signals. The topics cover the analysis, design and implementation of discrete-time systems. The mathematical representation of digital signals, their properties and manipulations are studied. The paradigm for analysis of system is built and time domain and various transform domain techniques for the analysis of LTI systems are explored including z-transform and Fourier analysis. The concepts of frequency selective filters are developed along with the design of filters with given specification. Students are required to design, simulate their projects on MATLAB, Simulink and/or VisualDSP++.

1. WEEKLY COURSE OUTLINE:

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| Week # | Contents |
| Week 1 | Introduction  Introductory topics, classification of signals, analog-to-digital conversion |
| Week 2 | Discrete Time Signals  Representation of Discrete-time signals and their properties |
| Week 3 | Discrete Time Systems  Transformations of the independent variable, properties of discrete-time signals |
| Week 4 | Analysis of Discrete Time Systems  Time domain analysis of discrete-time systems using convolution sum and difference equations |
| Week 5 | Analysis of Discrete Time Systems  Time domain analysis of discrete-time systems using convolution sum and difference equations |
| Week 6 | **Z-Transform**  Computing z-transform, Properties of Region of Convergence for z-transform, Computing inverse z-transforms, Properties of z-transform |
| Week 7 | **Z-Transform**  Computing z-transform, Properties of Region of Convergence for z-transform, Computing inverse z-transforms, Properties of z-transform |
| Week 8 | **Z-Transform Applications**  Analysis of LTI systems using z-transform |
|  | Midterm Examination |
| Week 9 | **One-Sided Z-Transform**  Computing one-sided z-transforms, Properties of one-sided z-transform, Analysis of LTI systems using one-sided z-transform |
| Week 10 | **One-Sided Z-Transform**  Computing one-sided z-transforms, Properties of one-sided z-transform, Analysis of LTI systems using one-sided z-transform |
| Week 11 | Frequency Analysis of Discrete Time Signals and Systems  Frequency domain representation of Discrete-time signals & systems and their properties |
| Week 12 | Frequency Analysis of Discrete Time Signals and Systems  Frequency domain representation of Discrete-time signals & systems and its properties |
| Week 13 | Analysis of Discrete Time LTI Systems in Frequency Domain  Response of LTI systems to sinusoidal & Exponential signals, Convolution in Frequency domain, frequency selective filters |
| Week 14 | Implementation of Discrete Time Systems  Structures for FIR Systems and IIR Systems |
| Week 15 | Filter Design Techniques  FIR Filter Design  Linear phase filter design by windowing, Kaiser window Method |
| Week 16 | Filter Design Techniques  **IIR Filter Design**  Filter design by impulse invariance, bilinear transformation |
|  | Final Term Examination |

1. MAPPING OF CLOS WITH PLOS:

After completing this course, students will be able to:

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| CLO # | Course Learning Outcomes (CLOs) | Level of Learning (Bloom's Taxonomy) | Program Learning Outcomes (PLOs) |
| 1 | Explain the working of digital signal processing systems and classify discrete time signals and systems into different categories. | Cog-2  (Comprehension) | PLO1  (Engineering Knowledge) |
| 2 | Analyze the discrete-time Linear Time Invariant (LTI) Systems in time and frequency domains | Cog-4  (Analysis) | PLO2 (Problem Analysis) |
| 3 | Compare different implementations of LTI systems. | Cog-4  (Analysis) | PLO4 (Investigation) |
| 4 | Design filters with desired characteristics which can be used for real world engineering problems | Cog-5  (Evaluating) | PLO3 (Design/Development of Solutions) |

1. MAPPING OF CLOs WITH COURSE ASSESSMENT TOOLS:

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| Course Assessment Tools | CLOs | | | |
| CLO 1 | CLO 2 | CLO 3 | CLO 4 |
| Assignments | ✓ | ✓ | ✓ | ✓ |
| Quizzes | ✓ | ✓ | ✓ | ✓ |
| Project |  |  | ✓ | ✓ |
| Midterm Exam | ✓ | ✓ | ✓ |  |
| Final Exam |  | ✓ | ✓ | ✓ |

1. RESOURCES:

* TEXT BOOKS
  + Discrete-Time Signal Processing Alan V. Oppenheim and Ronald W. Schafer, 3rd Edition, Prentice-Hall Signal Processing Series
  + Digital Signal Processing: Principles, Algorithms and Applications by J. P. Proakis and D. G. Manolakis. 4th Edition, Prentice Hall.
* REFERENCE BOOKS
  + Digital Signal Processing: A Practical Approach by Emanual C.Ifeachor, 2nd Edition, Prentice Hall.
  + Digital Signal Processing: A Computer Based Approach, 3nd Edition, Sanjit K. Mitra, McGraw-Hill