**Techno India NJR Institute of Technology**



**Course File**

**Signal & System (4EE4-07)**

Vivek Jain

(Associate Professor)

**Department of ECE**

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**Course Overview:**

Signals and Systems is an introduction to analog and digital signal processing, a topic that forms an integral part of engineering systems in many diverse areas, including seismic data processing, communications, speech processing, image processing, defence electronics, consumer electronics, and consumer products.

The course presents and integrates the basic concepts for both continuous-time and discrete-time signals and systems. Signal and system representations are developed for both time and frequency domains. These representations are related through the Fourier transform and its generalizations, which are explored in detail. Filtering and filter design, modulation, and sampling for both analog and digital systems, as well as exposition and demonstration of the basic concepts of feedback systems for both analog and digital systems, are discussed and illustrated.

**Course Outcomes:**

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| **CO.NO.** | **Cognitive Level** | **Course Outcome**  |
| 1 | **Comprehension** | Classify different types of signals and system properties. |
| 2 | **Application** | Demonstrate continuous and discrete systems in time and frequency domain using different transforms. |
| 3 | **Analysis** | Analyzewhether the system is stable. |
| 4 | **Synthesis** | Design and Develop Sampling and reconstruction circuit . |
| 5 | **Evaluation** | Evaluate the outputof the MIMO systems. |

**Prerequisites:**

1. Fundamentals knowledge of differentiation and integration.
2. Fundamentals knowledge of partial fraction.

**Course Outcome Mapping with Program Outcome:**

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| **Course Outcome**  | **Program Outcomes (PO’s)** |
| **CO. NO.** | **Domain Specific**  | **Domain Independent**  |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| CO1 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| CO2 | 2 | 1 | 0 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 1 |
| 1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)  |

**Course Coverage Module Wise:**

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| **Lecture No.** | **Unit** | **Topic** |
| 1 | **1** | **INTRODUCTION: OBJECTIVE, SCOPE AND OUTCOME OF THE COURSE.** |
| 2 | 1 | Energy signals power signals |
| 3 | 1 | Continuous and discrete time signals. |
| 4 | 1 | Discrete amplitude signals |
| 5 | 1 | Discrete amplitude signals |
| 6 | 1 | System properties: linearity: additivity and homogeneity |
| 7 | **2** | **SHIFT-INVARIANCE, CAUSALITY** |
| 8 | 2 | Stability, realizability |
| 9 | 2 | Linear shift-invariant (LSI) systems |
| 10 | 2 | Impulse response |
| 11 | 2 | Step response |
| 12 | 2 | Convolution |
| 13 | 2 | Input output behavior with aperiodic convergent inputs |
| 14 | **3** | **CHARACTERIZATION OF CAUSALITY AND STABILITY OF LINEAR SHIFT-INVARIANT SYSTEMS** |
| 15 | 3 | System representation through differential equations and difference equations |
| 16 | 3 | Characterization of causality and stability of linear shift-invariant systems |
| 17 | 3 | System representation through differential equations and difference equations |
| 18 | 3 | Periodic and semi-periodic inputs to an LSI system |
| 19 | 3 | The notion of a frequency response |
| 20 | 3 | Its relation to the impulse response |
| 21 | 3 | Fourier series representation |
| 22 | **4** | **FOURIER TRANSFORM** |
| 23 | 4 | Convolution/multiplication and their effect in the frequency domain |
| 24 | 4 | Magnitude and phase response |
| 25 | 4 | Fourier domain duality |
| 26 | 4 | The Discrete-Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT) |
| 27 | 4 | Parseval's Theorem. The idea of signal space and orthogonal bases |
| 28 | **5** | **THE LAPLACE TRANSFORM** |
| 29 | 5 | Notion of eigen functions of LSI systems |
| 30 | 5 | A basis of eigen functions, region of convergence |
| 31 | 5 | Poles and zeros of system, Laplace domain analysis |
| 32 | 5 | Solution to differential equations and system behavior |
| 33 | **6** | **THE Z-TRANSFORM FOR DISCRETE TIME SIGNALS AND SYSTEMS- EIGEN FUNCTIONS** |
| 34 | 6 | Region of convergence, z-domain analysis |
| 35 | 6 | State-space analysis and multi-input, multi-output representation |
| 36 | 6 | The state-transition matrix and its role |
| 37 | 6 | The Sampling Theorem and its implications- Spectra of sampled signals. |
| 38 | 6 | Reconstruction: ideal interpolator, zero-order hold, first-order hold |
| 39 | 6 | Aliasing and its effects |
| 40 | 6 | Relation between continuous and discrete time systems |

**TEXT/REFERENCE BOOKS**

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|  1. Signals and Systems, A.V. Oppenheim, A.S. Willsky and I.T. Young, Prentice Hall, 1983.
2. Signals and Systems - Continuous and Discrete, R.F. Ziemer, W.H. Tranter and D.R. Fannin ,4th edition, Prentice Hall, 1998.
3. Circuits and Systems: A Modern Approach, Papoulis, HRW, 1980.
4. Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press, 1998.
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**NPTEL COUSES LINK**

1. <https://nptel.ac.in/courses/108/106/108106163/>
2. <https://nptel.ac.in/courses/108/104/108104100/>

**QUIZ Link**

1. <https://www.sanfoundry.com/1000-signals-systems-questions-answers/>

**Faculty Notes Link**

1. https://drive.google.com/drive/folders/14RQFN1jlEgWi29XYo\_\_mM5lTYFXRXnVj?usp=sharing

**Assessment Methodology:**

1. Practical exam using MATALB software.
2. Two Midterm exams where student have to showcase subjective learning.
3. Final Exam (subjective paper) at the end of the semester.





