

## DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 5: DIGITAL SIGNAL PROCESSING

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Digital Signal Processing  Physics DSE 5	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Basics of digital electronics and analog electronics

### LEARNING OBJECTIVES

This paper describes the discrete-time signals and systems, Fourier transform representation of aperiodic discrete time signals. This paper also highlights the concept of filters and realization of digital filters. At the end of the syllabus, students will develop an understanding of discrete and fast Fourier transform.

### LEARNING OUTCOMES

At the end of this course, students will be able to develop following learning outcomes.

- Students will learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems.
- The student will be in position to understand use of different transforms and analyse the discrete time signals and systems. They will learn to analyse a digital system using z-transforms and discrete time Fourier transforms, region of convergence concepts, their properties and perform simple transform calculations.
- The student will realize the use of LTI filters for filtering different real world signals. The concept of transfer Function and difference-equation system will be introduced. Also, they will learn to solve difference equations.
- Students will develop an ability to analyse DSP systems like linear-phase, FIR, IIR, All-pass, averaging and notch Filter etc.
- Students will be able to understand the discrete Fourier transform (DFT) and realize its implementation using FFT techniques.
- Students will be able to learn the realization of digital filters, their structures, along with their advantages and disadvantages. They will be able to design and understand different types of digital filters such as finite and infinite impulse response filters for various applications.

### SYLLABUS OF PHYSICS DSE 5

#### THEORY COMPONENT

##### Unit – I

**(7 Hours)**

Discrete-Time Signals and Systems: Classification of signals, transformations of the independent variable, periodic and aperiodic signals, energy and power signals, even and odd signals, discrete time systems, system properties, impulse response, convolution sum, graphical and analytical method, properties of convolution (general idea), sum property system response to periodic inputs, relationship between LTI system properties and the impulse response

**Unit – II (9 Hours)**

Discrete time Fourier transform: Fourier transform representation of aperiodic discrete time signals, periodicity of DTFT, properties; linearity; time shifting; frequency shifting; differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. The z-Transform: Bilateral (Two-Sided) z-Transform, Inverse z- Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-plane, Region-of-Convergence; Differentiation in the z-Domain; Power Series Expansion Method (General Idea). Transfer Function and Difference-Equation System.

**Unit – III (10 Hours)**

Filter Concepts: Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters. Only Qualitative treatment  
Discrete Fourier Transform: Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation (General Idea), Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution).

**Unit – IV (4 Hours)**

Realization of Digital Filters: FIR Filter structures; Direct-Form; Cascade-Form  
Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR Filters

**References:**

**Essential Readings:**

- 1) Digital Signal Processing, T. K. Rawat, 2015, Oxford University Press, India
- 2) Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- 3) Principles of Signal Processing and Linear Systems, B. P. Lathi, 1<sup>st</sup> edition, 2009, Oxford University Press.
- 4) Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press
- 5) Digital Signal Processing Principles Algorithm & Applications, J. G. Proakis and D. G. Manolakis, 4<sup>th</sup> edition, 2007, Prentice Hall.

**Additional Readings:**

- 1) Digital Signal Processing, A. Kumar, 2<sup>nd</sup> edition, 2016, PHI learning Private Limited.
- 2) Digital Signal Processing, P. S. R. Diniz, E. A. B. da Silva and S. L. Netto, 2<sup>nd</sup> edition, 2017, Cambridge University Press

**PRACTICAL COMPONENT**

**(15 Weeks with 4 hours of laboratory session per week)**

- Introduction to numerical computation software Scilab/Matlab/Python be introduced in the lab.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab”

At least six experiments to be performed from the following using Scilab/ Matlab/ Python



**References for laboratory work:**

- 1) A Guide to MATLAB, B. R. Hunt, R. L. Lipsman and J. M. Rosenberg, 3<sup>rd</sup> edition, 2014, Cambridge University Press.
- 2) Fundamentals of Digital Signal processing using MATLAB, R. J. Schilling and S. L. Harris, 2005, Cengage Learning.
- 3) Getting started with MATLAB, R. Pratap, 2010, Oxford University Press.