Techno India NJR Institute of Technology

Course File

Digital Signal Processing (7EX5-11)

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For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

7EX5-11: DIGITAL SIGNAL PROCESSING

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Discrete-time signals and systems** Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Samplingand reconstruction of signals - aliasing; Sampling theorem and Nyquist rate	08
3	**Z-transform** z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using ztransform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.	06
4	**Discrete Fourier Transform** Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Connvolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems	10
5	**Design of Digital filters** Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Bandstop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing	11
6	**Applications of Digital Signal Processing** Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	06
	TOTAL	

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Course Overview:

The course covers theory and methods for digital signal processing including basic principles governing the analysis and design of discrete-time systems as signal processing devices. Review of discrete-time linear, time-invariant systems, Fourier transforms and z-transforms. Topics include sampling, impulse response, frequency response, finite and infinite impulse response systems, linear phase systems, digital filter design and implementation, discrete-time Fourier transforms, discrete Fourier transform, and the fast Fourier transform algorithms.

Course Outcomes:

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**	Analyze the output of IIR and FIR system .
4	**Synthesis**	Design and Develop Sampling and reconstruction circuit .
5	**Evaluation**	Evaluate the output of the MIMO systems.

Prerequisites:

1. Fundamentals knowledge of differentiation and integration.
2. Fundamentals knowledge of partial fraction.
3. Fundamentals knowledge of Z transform and Basic signals.

Course Outcome Mapping with Program Outcome:

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	2	1	2	0	0	0	0	0	0	0
CO2	2	2	2	2	2	0	0	0	0	0	0	0
CO3	1	2	2	2	3	0	0	0	0	0	0	0
CO4	3	2	3	3	1	0	0	0	0	0	0	0
CO5	3	2	2	3	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	**2**	**DISCRETE TIME SIGNALS**: Sequences
3	2	representation of signals on orthogonal basis
4	2	Sampling and reconstruction of signals
5	2	Sampling and reconstruction of signals
6	2	Discrete systems attributes
7	2	Discrete systems attributes
8	2	Z-Transform, Analysis of LSI systems
9	2	frequency Analysis of LTI systems
10	2	frequency Analysis of LTI systems
11	2	Inverse Systems
12	**3**	**DISCRETE FOURIER TRANSFORM (DFT)**
13	3	Discrete Fourier Transform (DFT)
14	3	Discrete Fourier Transform (DFT)
15	3	Fast Fourier Transform Algorithm
16	3	Fast Fourier Transform Algorithm
17	3	Fast Fourier Transform Algorithm
18	3	Fast Fourier Transform Algorithm
19	3	Implementation of Discrete Time Systems
20	3	Implementation of Discrete Time Systems
21	**4**	**DESIGN OF FIR DIGITAL FILTERS**
22	4	Window method
23	4	Park-McClellan's method
24	4	Design of IIR Digital Filters
25	4	Butterworth Approximation
26	4	Butterworth Approximation
27	4	Chebyshev and Elliptic Approximations
28	4	Chebyshev and Elliptic Approximations
29	4	Lowpass, Bandpass filter design
30	4	Band-Stop and High pass filters design

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31	**5**	**EFFECT OF FINITE REGISTER LENGTH IN FIR FILTER DESIGN**
32	5	Effect of finite register length in FIR filter design
33	5	Parametric spectral estimation
34	5	Parametric spectral estimation
35	5	Nonparametric spectral estimation
36	5	Nonparametric spectral estimation
37	5	Introduction to mult-irate signal
38	5	Introduction to mult-irate signal
39	5	Application of DSP
40	5	Application of DSP

TEXT/REFERENCE BOOKS

1. Digital Signal Processing: Principals, Algorithms And Applications", Proakis, Manolakis,4th ed., Pearson Education.
2. Discrete Time Signal Processing, Oppenheim, Schafer, 3rd ed. , PHI (2010).
3. Digital Signal Processing, Sanjit K Mitra, 4th ed., TMH.
4. Digital Signal Processing:A Modern Introduction,Ambardar, Cengage learning.

NPTEL COUSES LINK

1. https://nptel.ac.in/courses/117/102/117102060/

QUIZ Link

1. https://www.javatpoint.com/digital-signal-processing-mcq
2. ions-anhttps://www.sanfoundry.com/1000-digital-signal-processing-questswers/

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1. https://drive.google.com/drive/folders/1tz45RE6Fci2XRBp02k1rv8_2y9gp7vxj?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.

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5E1394

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B. Tech. V - Sem. (Main / Back) Exam., Feb.-March - 2021
PCC/PEC Electronics & Communication Engineering
5EC 4-04 Digital Signal Processing

Time: 2 Hours **[To be converted as per scheme]**

Max. Marks: 82

Min. Marks: 29

Instructions to Candidates:

Attempt all ten questions from Part A, four questions out of eight questions from Part B and two questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10×2=20]**

All questions are compulsory

Q.1 Explain about zero – order hold sampling.

Q.2 Explain the Sampling theorem for band pass signal.

Q.3 Write the advantages of representing the digital filter in the block diagram form.

Q.4 Compare Canonic structure and Non-Canonic structure.

Q.5 Explain Parseval's theorem for Discrete time sequence.

Q.6 Explain the relation between DFT and Z – transform.

Q.7 Explain Picket-Fence effect.

Q.8 Explain the application of DFT in linear filtering and spectrum analysis.

Q.9 Compare FIR filters and IIR filters.

Q.10 What do you mean by linear phase response?

PART – B

(Analytical/Problem solving questions) **[4×8=32]**

Attempt any four questions

Q.1 Find the Nyquist rate for the continuous time signal given below and find x[n]-

$$x(t) = \frac{\sin(4 \times 10^3 \pi t)}{\pi t}$$

Q.2 DFT of a sequence x(n) is given by-

$X(k) = \{6, 0, -2, 0\}$

Determine x(n).

Q.3 Find direct forms – II realizations for the second order filter given by-

$$y(n) = 2b\cos\omega_0 y(n-1) - b^2 y(n-2) + x(n) - b\cos\omega_0 x(n-1)$$

Q.4 Find the N – Point DFT of the following sequence-

$$h(n) = \begin{cases} \frac{1}{3} & \text{for } 0 \le n \le 2 \\ 0 & \text{elsewhere} \end{cases}$$

Q.5 Show that $z\left(\frac{1}{n+1}\right) = z\log\left(\frac{z}{z+1}\right)$, $n > 0$

Q.6 Write the short notes of design of IIR digital filter.

Q.7 A causal discrete – time LTI system is described by-

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n)$$

Where x(n) and y(n) are the input and output of the system, respectively. Determine the system function H(z) and impulse response h(n) of the system.

Q.8 Explain the concept of multirate signal processing and different application of DSP.

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PART – C

(Descriptive/Analytical/Problem Solving/Design Questions) **[2×15=30]**

Attempt any two questions

Q.1 Determine the 8-Point DFT of the following sequence-

$x[n] = \left\{\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, 0, 0, 0, 0\right\}$ use in place radix – 2 decimation in time FFT Algorithm.

Q.2 Draw the cascade and parallel realizations for the following system function-

$$H(z) = \frac{1+\frac{1}{4}z^{-1}}{\left(1+\frac{1}{2}z^{-1}\right)\left(1+\frac{1}{2}z^{-1}+\frac{1}{4}z^{-2}\right)}$$

Q.3 Using bilinear transformation, design Butterworth filter which satisfy the following condition-

$0.8 \le |H/e^{j\omega}| \le 1 \qquad 0 \le \omega \le 0.2\pi$

$|H/e^{j\omega}| \le 0.2 \qquad 0.6\pi < \omega < \pi$

Q.4 Compute the 8–point circular convolution for following sequence-

$x_1(n) = \{1, 1, 1, 1, 0, 0, 0, 0\}$

$x_2(n) = \sin\left(\frac{3\pi n}{8}\right) \quad 0 \le n \le 7$

Q.5 Determine the impulse response of h(n) for the system described by the second order difference equation-

$y(n) - 4y(n-1) + 4y(n-2) = x(n) - x(n-1)$

Where $y(-1) = y(-2) = 0$

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