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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: VI - THEORY EXAMINATION (2025 - 2026)

Subject: Digital Signal Processing

Time: 3 Hours

Max. Marks: 100

General Instructions:

IMP: Verify that you have received the question paper with the correct course, code, branch etc.

1. This Question paper comprises of **three Sections -A, B, & C**. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.

2. Maximum marks for each question are indicated on right -hand side of each question.

3. Illustrate your answers with neat sketches wherever necessary.

4. Assume suitable data if necessary.

5. Preferably, write the answers in sequential order.

6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION-A

20

1. Attempt all parts:-

- (1.1) The output spectrum of DTFT will be in the form of.... (CO1, K1) 1
- Periodic Discrete time signals
 - Aperiodic Discrete time signals
 - Aperiodic continuous signals
 - Periodic continuous signals
- (1.2) In an 8-point DFT by radix-2 FFT ,there are..... stages of computations with..... Butterflies per stage. (CO1,K2) 1
- 3,3
 - 3,4
 - 4,4
 - 4,3
- (1.3) The transformation technique in which there is one to one mapping from s-domain to z-domain is... (CO2,K1) 1
- Backward difference for the derivative
 - Bilinear transformation method
 - Impulse invariance method
 - Approximation of derivatives
- (1.4) The poles of butterworth filter lie on a... (CO2, K1) 1
- circle
 - parabola
 - ellipse
 - helix

- (1.5) Linear phase system have a constant... (CO3, K2) 1
- (a) Phase
 - (b) Group delay
 - (c) magnitude
 - (d) angle
- (1.6) In FIR filter..... function is a linear function of frequency. (CO3,K1) 1
- (a) Phase
 - (b) amplitude
 - (c) frequency
 - (d) None of these
- (1.7) When the no of delays is equal to order of the system, the structure is called... (CO4,K1) 1
- (a) Canonic
 - (b) Noncanonic
 - (c) Cascade
 - (d) None of these
- (1.8) The linear phase realization is used in FIR system in order to minimize.... (CO4,K2) 1
- (a) multiplier
 - (b) memory
 - (c) delay
 - (d) adders
- (1.9) Decimation process is used to.... (CO5, K1) 1
- (a) decrease the sampling rate
 - (b) Increase the sampling rate
 - (c) no change
 - (d) None of these
- (1.10) What is the process of converting a signal from a given rate to a different rate? (CO5,K1) 1
- (a) Sampling
 - (b) Normalizing
 - (c) Sampling rate conversion
 - (d) None of the mentioned

2. Attempt all parts:-

- (2.1) Write down the formula of DFT and IDFT. (CO1,K1) 2
- (2.2) Differentiate between Butterworth and Chebyshev filter. (CO2,K2) 2
- (2.3) Define phase delay and group delay. (CO3, K2) 2
- (2.4) Write the advantages of cascade and parallel form realization in IIR system. (CO4,K2) 2
- (2.5) List out the advantages of multirate signal processing. (CO5,K2) 2

SECTION-B

30

Answer any one of the following:-

- (3.1) Compute the 4-point DFT of a given sequence $x(n)=\{1,2,3,4\}$. Also sketch the magnitude and phase spectrum. (CO1, K3) 6
- (3.2) Given $x(n)=\{0,1,2,3\}$, find $X(k)$ using DIT-FFT algorithm. Also, sketch the magnitude and phase spectrum. (CO1,K3) 6

Answer any one of the following:-

- (3.3) Determine $H(z)$ using the impulse invariant technique for the analog system function for $T=1\text{sec}$. (CO2,K3) 6

$$H(s) = \frac{1}{(s+1)(s^2+5s+6)}$$

- (3.4) Compare FIR and IIR filters. Write the equations for order and cut-off frequency of Butterworth filter? (CO2,K2) 6

Answer any one of the following:-

- (3.5) Explain the window method for designing of FIR filter. Also, compare Rectangular window with Hamming window.(CO3,K3) 6
- (3.6) Write a short note on : (a) Zero input limit cycle (b) overflow limit cycle. (CO3,K2) 6

Answer any one of the following:-

- (3.7) Illustrate the cascade and parallel form realizations of IIR system with example. (CO4,K3) 6
- (3.8) Determine the linear-phase and cascade form realization of the system function: (CO4,K4) 6

$$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{17}{8}z^{-2} + \frac{3}{4}z^{-3} + z^{-4}$$

Answer any one of the following:-

- (3.9) Compute and draw the up sampled version of signals for up sampling factor (a) $I=2$ (b) $I=3$ (c) $I=4$ for discrete time signal $x(n)=\{1,2,3,4,5,6\}$, (CO5,K3) 6
- (3.10) What is sub-band coding of speech signal? Also explain the application of sub-band coding of speech signal in multirate signal processing. (CO5, K2) 6

SECTION-C 50

4. Answer any one of the following:-

- (4.1) Write down the differences between linear and circular convolution. Also Obtain linear convolution of the sequences $x(n) = \{1,2,3,4\}$ and $h(n) = \{3, 4, 5\}$ using circular convolution. (CO1,k4) 10
- (4.2) Define bit reversal and in place computation. Also compute the 4-point DFT of the given sequence $x(n) = \{1,2,1,2\}$ using DIF-FFT algorithm. (CO1, K4) 10

5. Answer any one of the following:-

- (5.1) Drive the expression for relationship between analog and digital frequency for bilinear transformation method. Also, convert the analog filter with system 10

function:
$$H(s) = \frac{s+0.1}{(s+0.1)^2+16}$$

into digital IIR filter by means of bilinear transformation. The digital filter is to have a resonant frequency $\omega = \pi/2$. (CO2,K3)

- (5.2) Compute the poles of an analog Butterworth filter transfer function that satisfies the constraints. 10

$$0.707 \leq |H(j\Omega)| \leq 1 \quad 0 \leq \Omega \leq 2$$

$$|H(j\Omega)| \leq 0.1 \quad \Omega \geq 4$$

and determine $H(s)$ and hence obtain $H(z)$ using BLT method. ($T=1s$). (CO2,K4)

Question Instruction

Not applicable

6. Answer any one of the following:-

- (6.1) For the desired frequency response 10

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega} & \omega_{c1} \leq |\omega| \leq \omega_{c2} \\ 0 & |\omega| < \omega_{c1}, \quad \omega_{c2} < |\omega| \leq \pi \end{cases}$$

Determine frequency response of design filter for $M=7$ using Blackman/Hamming window if lower and upper cut off frequency are $\pi/4$ and $\pi/2$ respectively. (CO3,K4)

Question Instruction

not applicable

- (6.2) Design a linear phase low pass digital filter if the desired frequency response is giving by 10

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega} & 0 \leq |\omega| \leq \pi/2 \\ 0 & \pi/2 \leq |\omega| \leq \pi \end{cases}$$

Using the Bartlett window with filter length $M=5$, find the impulse response and frequency response of designed filter. Determine the system function and difference equation. Also draw the linear phase structure of designed filter. (CO3,K4)

7. Answer any one of the following:-

- (7.1) Given system function 10

$$H(z) = \frac{2 + 8z^{-1} + 6z^{-2}}{1 + 8z^{-1} + 12z^{-2}} \quad \text{Realise using ladder structure. (CO4,K3)}$$

- (7.2) Draw the direct form-I and direct form -II structure of a given system describe by the following equation. (CO4,K4) 10

$$(a) y(n) = y(n-1) - 0.5 y(n-2) + x(n) - x(n-1) + x(n-2)$$

$$(b) y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.45y(n-3) + 0.7x(n) - 0.5x(n-1) - 0.252x(n-2)$$

8. Answer any one of the following:-

- (8.1) Derive and explain the frequency domain analysis of interpolation process with neat diagram. (CO5, K4) 10

- (8.2) Explain the process of Two channel Quadrature Mirror Filter bank with suitable block diagram. Also write down the main applications of QMF bank. (CO5, K3) 10