

R16

Code No: 137BX

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech IV Year I Semester Examinations, July/August - 2023

DIGITAL SIGNAL PROCESSING
(Electrical and Electronics Engineering)

Time: 3 Hours

Max.Marks:75

Note: i) Question paper consists of Part A, Part B.

ii) Part A is compulsory, which carries 25 marks. In Part A, answer all questions.

iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

- 1.a) What are the conditions for stability and causality of an LSI system? [2]
- b) What is the difference between Direct and Canonic form structures? [3]
- c) Obtain the relation between DFT and DFT. [2]
- d) Compute the 4-point DFT of $x(n) = \{1,0,1,0\}$ using DIT-FFT algorithm. [3]
- e) What is the drawback of impulse invariance technique? [2]
- f) Obtain the equivalent digital transfer function $H(z)$ by using Bilinear transformation for the analog transfer function $H(s) = 1/(S+4)$. Assume $T=0.5$ sec. [3]
- g) How is Kaiser window superior to other window function? [2]
- h) Compare IIR and FIR filter. [3]
- i) What is Multirate signal processing? [2]
- j) What are the different methods to prevent flow in Digital filters? [3]

PART – B

(50 Marks)

- 2.a) Explain the method of obtaining the frequency response of linear shift-invariant systems.
- b) For the following discrete time signals, determine whether or not the system is linear, shift invariant, causal and stable
i) $y(n) = \cosh[nx(n) + x(n - 1)]$ ii) $y(n) = x(-n - 2)$ [5+5]

OR

- 3.a) Find the output response of the discrete time system described by the following difference equation $y(n) - 0.37y(n - 1) + 0.132y(n - 2) = x(n)$ where $x(n) = \left(\frac{6}{7}\right)^n u(n)$ subjected to the initial conditions $y(-1) = 1$ and $y(-2) = 2$. Also find out the step response
- b) Obtain direct form I, direct form II and cascade realizations of system described by the equation, $y(n) = y(n - 1) - \frac{1}{2}y(n - 2) + x(n) - x(n - 1) + x(n - 2)$. [5+5]

- 4.a) State and prove Circular shift of a Sequence and Time Shifting property of DFT.
- b) Find the IDFT of $X[k] = [10, -2+j2, 4, -2-j2]$ using DIF-FFT algorithm. [5+5]

OR

- 5.a) Find the circular convolution using Overlap Save and Overlap Add methods of the sequence $x_1(n) = \{4,3,1,2\}$ and $x_2(n) = \{1,3,5,3\}$.
- b) Obtain the 4-point circular convolution of $x(n) = \{4,3,2,1\}$ and $h(n) = \{1,1,1,1\}$ using Radix-2 DIT-FFT algorithm. [5+5]

- 6.a) With necessary equations derive the transfer function of third order Butterworth filter.
 b) Determine the system function $H(Z)$ of the lowest order Chebyshev digital filter that has 3 dB ripple in the passband $0 \leq |\omega| \leq 0.3\pi$ with at least 40 dB attenuation in the stopband $0.35\pi \leq |\omega| \leq \pi$. Use the bilinear transformation method. [5+5]

OR

- 7.a) Discuss the design procedure of Bilinear transformation method. Also explain the drawbacks using the Bilinear transformation method and how they can be avoided?
 b) Design a digital Butterworth filter that satisfies the following constraint using impulse invariance method. [5+5]

$$0.8 \leq |H(e^{j\omega})| \leq 1.0, 0 \leq \omega \leq 0.8\pi$$

$$|H(e^{j\omega})| \leq 3, \frac{5\pi}{4} \leq \omega \leq \pi$$

- 8.a) Prove that FIR filter has linear phase if the unit impulse response satisfies the condition $h(n) = h(N-1-n)$, $n=0,1,\dots,M-1$. Also discuss symmetric and antisymmetric cases of FIR filter.
 b) Design a High Pass FIR filter whose cut-off frequency is 1.6 radians/sec and $N = 11$ using Hamming Window. [5+5]

OR

- 9.a) Explain FIR filter design using windowing method.
 b) The desired frequency response of a low pass filter is

$$H(e^{j\omega}) = \begin{cases} 1 & -\frac{\pi}{4} \leq |\omega| \leq \frac{\pi}{4} \\ 0 & \frac{\pi}{4} \leq |\omega| \leq \pi \end{cases}$$

Determine $h_d(n)$ for $M = 7$ using a rectangular window. [5+5]

- 10.a) Describe the frequency domain characterization of Upsampling.
 b) What is the need for signal scaling? How the overflow error scaling is performed? [5+5]

OR

- 11.a) With necessary derivations explain the operation of sampling rate conversion by a factor of I/D in both frequency and time domains.
 b) Discuss the effects of Dead Band in detail. [5+5]

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