CBCS SCHEME

USN | | | | | | | | | |

15MT73

Seventh Semester B.E. Degree Examination, June/July 2023
Signal Process

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define a signal. Explain the classification of signals. **(08 Marks)**

b. A discrete time signal x(n) is described by

$$x(n) = \begin{cases} 1 & n = 1,\ 2,\ 3 \\ -1 & n = -1, -2, -3 \\ 0 & n = 0, |n| > 3. \end{cases}$$

(08 Marks)

OR

2 a. Explain the following properties of systems :
i) Linearity ii) Causality iii) Time in variance iv) Memory. **(08 Marks)**

b. For a system describe by $T\{x(n)\} = ax(n) + b$. Check for the following properties :
i) Stability ii) Causality iii) Linearity iv) Time invariance v) Memory. **(08 Marks)**

Module-2

3 a. An LTI system is characterized by an impulse response : $h(n) = \left(\frac{3}{4}\right)^n u(n)$. Find the step response of the system. Also, evaluate the output of the system at $n = \pm 5$. **(08 Marks)**

b. Find the convolution sum of the two sequences $x_1(n)$ and $x_2(n)$ given below :

$x_1(n) = (\underset{\uparrow}{1}, 2, 3)$

$x_2(n) = (\underset{\uparrow}{2}, 1, 4)$. **(08 Marks)**

OR

4 a. Explain the convolution integral for an linear time invariant system. **(08 Marks)**

b. Convolute the two continuous time signals $x_1(t)$ and $x_2(t)$ given below :
$x_1(t) = \cos \pi t[u(t + 1) - u(t - 3)]$
$x_2(t) = u(t)$. **(08 Marks)**

Module-3

5 a. Compute the 8 point DFT of the sequence x(n) given below :
$x(n) = (1, 1, 1, 1, 0, 0, 0, 0)$. **(08 Marks)**

b. Compute the inverse DFT of the sequence :
$x(k) = (2, 1 + j, 0, 1 - j)$. **(08 Marks)**

OR

6 a. Perform $x(n) * h(n)$, $0 \le n \le 11$ for the sequence x(n) and h(n) given below using overlap add fast convolution technique.
$h(n) = (1, 1, 1)$
$x(n) = (1, 2, 0, -3, 4, 2, -1, 1, -2, 3, 2, 1, -3)$. **(08 Marks)**

b. Find the 8 point DFT of the sequence $x(n) = (1, 2, 3, 4, 4, 3, 2, 1)$ using DIT – FFT radix 2 algorithm. **(08 Marks)**

Module-4

7 a. A Butterworth lowpass filter has to meet the following specifications :

i) Pass band gain, KP = –1 dB at $\Omega_p = 4$ rad/sec

ii) Stop band attenuation greater than or equal to 20dB at $\Omega_s = 8$ rad /sec. Determine the transfer function $H_a(s)$ of the lowest order Butterworth filter to meet the above specifications. **(08 Marks)**

b. Design a Chebyshev I filter to meet the following specification :

i) Pass band Ripple ≤ 2 dB
ii) Pass band Edge : 1 rad/sec
iii) Stop band attenuation ≥ 20dB
iv) Stop band edge : 1.3 rad/sec. **(08 Marks)**

OR

8 a. A third order Butterworth low pass filter has the transfer function :

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

Design H(z) using impulse invariant technique. **(08 Marks)**

b. Determine the system function H(z) of the lowest order Chebyshev filter that meets the following specifications :

i) 3 dB ripple in the pass band $0 \leq \omega \leq 0.3\pi$

ii) At least 20 dB attenuation in the stop band $0.6\pi \leq |\omega| \leq \pi$. Use the bilinear transformation. **(08 Marks)**

Module-5

9 a. A low pass filter is to be designed with the following desired frequency response :

$$H_d(e^{j\omega}) = H_d(\omega) = \begin{cases} e^{-j2\omega}, & |\omega| < \pi/4 \\ 0, & \pi/4 < |\omega| < \pi. \end{cases}$$

Determine the filter coefficients $h_d(n)$ and h(n) if ω(n) is a rectangular window defined as follows :

$$\omega_R(n) = \begin{cases} 1, & 0 \leq n \leq 4 \\ 0, & \text{otherwise} \end{cases}$$

Also find the frequency response H(ω) of the resulting FIR filter. **(08 Marks)**

b. The desired frequency response of a low pass filter is given by :

$$H_d(e^{j\omega}) = H_d(\omega) = \begin{cases} e^{-j2\omega}, & |\omega| < 3\pi/4 \\ 0, & 3\pi/4 < |\omega| < \pi \end{cases}$$

Determine the frequency response of the FIR filter is Hamming window is used with N = 7. **(08 Marks)**

OR

10 a. Sketch the direct form – I, direct form II and transposed realization for the system function give below :

$$H(z) = \frac{2z^2 + z - 2}{z^2 - 2}.$$ **(08 Marks)**

b. Obtain a cascade realization for a system described by :

$$H(z) = \frac{1 + \frac{1}{4}z^{-1}}{\left(1 + \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}\right)}$$ **(08 Marks)**

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