USN | | | | | | | | | | 17EC52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Describe the process of frequency domain sampling and reconstruction of discrete time signal. **(10 Marks)**

b. Find the 4-point DFT of the sequence x(n) = {1, 2, 3, 4} and verify the result with IDFT using matrix method. **(10 Marks)**

OR

2 a. Determine the 8-point DFT of the sequence x(n) = {1, 1, 1, 1, 1, 1, 0, 0}. **(08 Marks)**

b. Using Concentric circular method obtain 5 point circular convolution of two DFT signal defined by

$x(n) = (1.5)^n \quad ; \quad 0 \le n \le 2$

$y(n) = (2n - 3) \quad ; \quad 0 \le n \le 3$ **(08 Marks)**

c. State and prove Linearity property of DFT. **(04 Marks)**

Module-2

3 a. State and prove circular time shift of DFT. **(06 Marks)**

b. A length – 6 sequence x(n) = {1, 3, −2, 1, −3, 4} with 6- point DFT given by x(k). Evaluate the following function $\sum_{k=0}^{5} |X(K)|^2$ without computing DFT. **(04 Marks)**

c. Find the output y(n) of a filter where the input response h(n) = {1, 1, 1} and the input signal x(n) = {3, −1, 0, 1, 3, 2, 0, 1, 2, 1} using overlap – save method assuming the length of the block is 8. **(10 Marks)**

OR

4 a. State and prove circular frequency shift property in DFT. **(05 Marks)**

b. Determine the number of complex multiplication complex addition real multiplication, real addition and trigonometric function for N = 8 and N = 16 for direct computation of DFT. **(05 Marks)**

c. Using over-lap add method compute y(n) of a FIR filter with impulse response h(n) = {3, 2, 1} and input x(n) = {2, 1, −1, −2, −3, 5, 6, −1, 2, 0, 2, 1}. Use 8 – point circular convolution in your approach. **(10 Marks)**

Module-3

5 a. Find the 8-point DFT of the sequence x(n) = {1, 2, 3, 4, 4, 3, 2, 1} using DIT – FFT radix – 2 algorithm. **(10 Marks)**

b. Describe Goertzel algorithm. Also obtain direct form – I and Direct form – II realization. **(10 Marks)**

OR

6 a. Find the IDFT of the following sequence using DIF-FFT algorithm

$$x(k)=\left\{\frac{7}{2},\frac{1}{2},-\frac{1}{2},\frac{1}{2},-\frac{1}{2},\frac{1}{2},-\frac{1}{2},\frac{1}{2}\right\}$$ **(10 Marks)**

b. Compute the 4-point DFT of the sequence using DIT-FFT algorithm $x(n) = \{1, 0, 1, 0\}$. **(04 Marks)**

c. For sequence $x(n) = (1, 0, 1, 0)$ determine $x(2)$ using Goertzel algorithm. Assume initial conditions are zero. **(06 Marks)**

Module-4

7 a. Sketch the direct – form – I and direct form – II realization for the system function. Given below $H(z)=\dfrac{2z^{-2}+z-2}{z^2-2}$. **(10 Marks)**

b. Design a digital Butterworth low pass filter with frequency specifications given :

i) Pass band ≤ 3.01dB
ii) Pass band edge frequency : 500Hz
iii) Stop band attenuation : ≥ 15dB
iv) Stop band edge frequency : 750Hz
v) Sampling rate $f_s = 2$KHz

Use bilinear transformation method. **(10 Marks)**

OR

8 a. Obtain the cascade form realization for the system given by

$$H(z)=\frac{1-\frac{1}{2}z^{-1}}{\left[1-\frac{1}{4}z^{-1}+\frac{1}{2}z^{-2}\right]\left[1-\frac{1}{5}z^{-1}+\frac{1}{6}z^{-2}\right]}.$$ **(06 Marks)**

b. A digital filter is given by

$$H(z)=\frac{1-\frac{1}{2}z^{-1}}{\left(1-\frac{1}{3}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}.$$ **(06 Marks)**

c. An analog filter is given by $H_a(s)=\dfrac{3}{(s+3)(s+1)}$ with T = 1Sec. Obtain H(z) using bilinear transformation. **(08 Marks)**

Module-5

9 a. Given FIR filter with $y(n) = x(n) + 3.1x(n-1) + 5.5\,x(n-2) + 4.2\,x(n-3) + 2.3\,x(n-4)$. Sketch the lattice structure. **(10 Marks)**

b. The desired frequency response of a lowpass filter is given by

$$H_d(w)=\begin{cases} e^{-j3w} & ; \quad |w|<\frac{3\pi}{4} \\ 0 & ; \quad \frac{3\pi}{4}<|w|<\pi \end{cases}$$

Determine the frequency response of the FIR filter if Hamming window is used with N = 7. **(10 Marks)**

OR

10 a. Realize the system function given by

$H(z) = 1 + \frac{1}{3}z^{-1} + \frac{1}{5}z^{-2}\frac{1}{4}z^{-3} + \frac{1}{8}z^{-4} + \frac{1}{9}z^{-5} + \frac{1}{2}z^{-6}$ in direct form. **(04 Marks)**

b. Obtain the cascade form realization of system function

$H(z) = 1 + \frac{5}{4}z^{-1} + 2z^{-1} + 2z^{-3}$ **(06 Marks)**

c. A Lowpass filter is to designed with the following desired frequency response

$$H_d(w) = \begin{cases} e^{-j2w} & ; \quad |w| < \pi/4 \\ 0 & ; \quad \frac{\pi}{4} < |w| < \pi \end{cases}$$

Determine the filter coefficient $h_d(n)$ if $w(n)$ is a rectangular window defined as

$$W_R(n) = \begin{cases} 1 & ; \quad 0 \le n \le 4 \\ 0 & ; \quad \text{otherwise} \end{cases}$$

Also find the frequency response $H(w)$ of the resulting FIR filter. **(10 Marks)**

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