USN

10EE64

Sixth Semester B.E. Degree Examination, June/July 2023
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. State and prove that following properties of DFT
i) Linearity ii) circular frequency shift **(06 Marks)**

b. Find the 8-poinet DFT of the sequence
$x(n) = 1$ for $0 \le n \le 3$
$= 0$, for $4 \le n \le 7$ **(08 Marks)**

c. Let $x(n) = (1, 2, -3, 0, 1, -1, 4, 2)$. Evaluate the following without computing DFT
i) $x(0)$ ii) $x(4)$ iii) $\sum_{k=0}^{7} X(k)$ iv) $\sum_{k=0}^{7} |X(k)|^2$ **(06 Marks)**

2 a. Determine the circular convolution of the following sequence using DFT and IDFT method.
$x_1(n) = \{1, 1, 2, 1\}$ $x_2(n) = \{1, 2, 3, 4\}$ **(10 Marks)**

b. Find the output $y(n)$ of a filter whose impulse response is $h(n) = (1, 1, 1)$ and input $x(n) = (3, -1, 0, 1, 3, 2, 0, 1, 2, 1)$, using overlap add method. Use only 5-point circular convolution. **(10 Marks)**

3 a. Find the number of computations required to find the DFT of 32-point sequence using i) Direct method ii) DIT FFT algorithm. Also find the speed improvement factor. **(06 Marks)**

b. Find the 8-point DFT of a sequence $x(n) = (1, 1, 1, 1, 0, 0, 0, 0)$ using DIT-FFT radix-2 algorithm. **(10 Marks)**

c. What are the differences and similarities between DIT and DIF algorithms? **(04 Marks)**

4 a. Find the circular convolution of the sequences $x(n) = (1, 1, 1, 1)$ and $h(n) = (1, 0, 1, 0)$ using DIF – FFT algorithm. **(10 Marks)**

b. Develop DIT – FFT algorithm for composite value of $N = 9$. Draw the corresponding signal flow graph. **(10 Marks)**

PART – B

5 a. The system function of analog filter is given as $H_a(s) = \frac{10}{s^2 + 7s + 10}$. Obtain $H(z)$ using impulse invariant transformation. Take $T = 0.2$ seconds. **(12 Marks)**

b. A digital low pass Butterworth filter is required to meet the following specifications
i) -3.01dB cut-off frequency of 0.5π radians
ii) Stop band attenuation of atleast 15dB at 0.75π radians.
Find the system function $H(z)$ using Bilinear transformation for $T = 1$ Sec. **(08 Marks)**

6 a. Distinguish between Butterworth and Chebyshev – I filter. **(04 Marks)**

b. Design a Chebyshev analog lowpass filter that has – 3.01dB cutoff frequency of 100 rad/sec and a stopband attenuation of 25dB or greater for all frequencies past 250 rad/sec. **(10 Marks)**

c. Derive expression for poles from squared magnitude response of Butteworth lowpass filter for cutoff frequency of 1 rad/sec. **(06 Marks)**

7 a. A lowpass filter has the desired frequency response

$$H_d(w) = H_d(e^{jw}) = \begin{cases} e^{-j3w} & 0 < w < \frac{\pi}{2} \\ 0 & \frac{\pi}{2} < w < \pi \end{cases}$$

Determine h(n) based on frequency sampling method. Take N = 7. **(12 Marks)**

b. A low pas filter is to be designed with the following desired frequency response.

$$H_d(e^{jw}) = \begin{cases} e^{-j2w} & -\frac{\pi}{4} \le w \le \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < w \le \pi \end{cases}$$

Determine the filter coefficient $h_d(n)$ and h(n) if the window function is defined as

$$W_R(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0 & \text{Otherwise} \end{cases}$$

(08 Marks)

8 a. Determine the direct forms I and II for the IIR filter given by
$y(n) = 2b \cos w_0 y(n-1) - b^2 y(n-2) + x(n) - b \cos w_0\, x(n-1)$. **(08 Marks)**

b. Determine the parallel form realization of the IIR digital filter transfer function

$$H(z) = \frac{3(2z^2 + 5z + 4)}{(2z+1)(z+2)}.$$

(06 Marks)

c. Realize the linear phase FIR filter having the following impulse response

$$h(n) = \delta(n) - \frac{1}{4}\delta(n-1) + \frac{1}{2}\delta(n-2) + \frac{1}{2}\delta(n-3) - \frac{1}{4}\delta(n-4) + \delta(n-5)$$

(06 Marks)

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