USN

10TE52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO full questions from each part.*
2. Use of normalized Chebyshev and Butterworth prototype tables are not allowed.

PART – A

1 a. Find the DFT of a sequence $x(n)=\begin{cases}1 & \text{for } 0\le n\le 2\\ 0 & \text{otherwise}\end{cases}$ for N = 4. Plot magnitude of the DFT X(k). **(06 Marks)**

b. What is the relationship between DFT and DFS? **(02 Marks)**

c. If DFT {x(n)} = X(k), then show that

i) $\text{DFT}\{x((-n))_N\} = X((-k))_N$ ii) $\text{DFT}\{W_N^{-Ln}x(n)\} = X((k-\ell))_N$ **(12 Marks)**

2 a. Determine the response of an LTI system with h(n) = {1, -1, 2} for an input x(n) = {1, 0, 1, -2, 1, 2, 3, -1, 0, 2}. Use overlap add method with block length N = 4. **(12 Marks)**

b. Consider the sequence x(n) = {8, 3, 4, 1, -5, -4, -20, 2, -1, 7, 4}. Evaluate the following without explicitly computing X(k):

i) $\sum_{k=0}^{10} X(k)$ ii) $\sum_{k=0}^{10} |X(k)|^2$ **(08 Marks)**

3 a. Derive DIT-FFT algorithm for N = 8 and draw the complete signal flow graph. **(12 Marks)**

b. What is in-place computation? What is the total number of complex additions and multiplications required for N = 512 point, if DFT is computed directly and if FFT is used? **(04 Marks)**

c. Compute the 4-point DFT of the sequence x(n) = {1, 0, 1, 0} using DIF FFT radix-2-Algorithm. **(04 Marks)**

4 a. Given x(n) = n + 1 and N = 8. Determine X(k) using DIF-FFT algorithm. **(12 Marks)**

b. Write a note on chirp z-transform algorithm. **(04 Marks)**

c. Given x(n) = {1, 0, 1, 0}, find X(2) using Goertzel algorithm. **(04 Marks)**

PART – B

5 a. Bring out a comparison between Butterworth filter and Chebyshev filter. **(04 Marks)**

b. Design Butterworth filter for following specifications:

$$0.8 \le |H_a(s)| \le 1 \quad \text{for} \quad 0 \le f \le 1000\text{Hz}$$
$$|H_a(s)| \le 0.2 \text{ for} \quad f \ge 5000\text{Hz}$$ **(10 Marks)**

c. Derive an expression for order of the Chebyshev filter. **(06 Marks)**

6 a. Design a FIR low pass filter with a desired frequency response

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

Use Hamming window with M = 7. **(10 Marks)**

b. Design a lowpass FIR filter using frequency sampling technique having cut off frequency of $\frac{\pi}{2}$ rad/sample. The filter should have linear phase and length of 17. **(10 Marks)**

7 a. Let $H_a(S) = \dfrac{S+a}{(S+a)^2 + b^2}$ be a causal second order analog transfer function. Show that the casual second-order digital function H(z) is obtained from $H_a(S)$ through impulse invariance method is given by

$$H(z) = \frac{1 - e^{-aT}\cos bTz^{-1}}{1 - 2\cos bT\,e^{-aT}z^{-1} + e^{-2aT}z^{-2}}$$ **(08 Marks)**

b. What are the limitations of Impulse invariance method? **(02 Marks)**

c. Design a digital butterworth filter satisfying the following constraints using bilinear transform. Assume T = 1sec.

$$0.9 \le |H(e^{jw})| \le 1 \quad 0 \le w \le \pi/2;$$
$$|H(e^{jw})| \le 0.2 \quad 3\pi/4 \le w \le \pi$$ **(10 Marks)**

8 a. If $H_a(S) = \dfrac{1}{(S+2)(S+1)}$; find the corresponding H(z) using Impulse invariance method for sampling frequency of 5 samples/sec. **(05 Marks)**

b. Obtain the cascade realization of system function

$$H(z) = 1 + \frac{5}{z}z^{-1} + 2z^{-2} + 2z^{-3}$$ **(05 Marks)**

c. Consider the system function

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

i) Realize the system in direct form – I
ii) Realize the system in parallel form using first and second order direct form II sections. **(10 Marks)**

* * * * *