USN

10MT74

Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Filter Table is permitted***

PART – A

1 a. Find the N-point DFT of the sequence $x(n) = e^{jwmn}$, $0 \le n \le N-1$ and $w = \frac{2\pi}{N}$. **(05 Marks)**

b. Find the 8-point DFT of the sequence x(n) = {1, 1, 1, 1, 0, 0, 0, 0} **(10 Marks)**

c. Establish the relation between DFT and z-transform. **(05 Marks)**

2 a. State and prove circular folding property of an N-point sequence. **(05 Marks)**

b. Find the four point circular convolution of the sequence $x(n) = \cos\left(\frac{n\pi}{2}\right)$, $h(n) = 2^n$; $0 \le n \le 3$. **(05 Marks)**

c. Let x(n) be a finite length sequence with X(K) = (0, 1 + j, 1, 1 – j). Using the properties of DFT, find DFT of the following sequences.

i) $x_1(n) = e^{j\pi/2\, n} x(n)$ ii) $x_2(n) = \cos\left(\frac{n\pi}{2}\right) x(n)$

iii) $x_3(n) = x((n-1))_4$ iv) $x_4(n) = (0,0,1,0) \otimes_4 x(n)$ **(10 Marks)**

3 a. In the direct computation of 64-point DFT of x(n) how many (i) complex multiplications ii) complex additions (iii) Real multiplications (iv) Real additions (v) Trigonometric function evaluations are required? **(05 Marks)**

b. Prove : i) Symmetry ii) Periodicity property of a twiddle factor. **(05 Marks)**

c. Find the output y(n) of a filter whose impulse response $h(n) = \left(\overset{\downarrow}{3}, 2, 1, 1\right)$ and input signal x(n) = {1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1} using overlap add method. Assume the length of the block as 7. **(10 Marks)**

4 a. Find 8-point DFT of a sequence $x(n) = \{\underset{\uparrow}{0}, 0.707, 1, 0.707, 0, -0.707, -1, -0.707\}$. Using radix -2 DITFFT algorithm. Draw the signal flow graph. **(06 Marks)**

b. Develop 8-point DIFFFT radix-2 algorithm and draw the signal flow graph. **(10 Marks)**

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

PART – B

5 a. For an analog Butterworth filter, derive an expression for order 'N' of lowpass filter. **(05 Marks)**

b. Compare Butterworkth and Chebychev filters. **(05 Marks)**

c. Design a Chebychev – I filter to meet the following specifications :
   i) Passband ripple : ≤ 2 dB
   ii) Passband edge frequency : 1 rad/sec
   iii) Stopband attenuation : ≥ 20dB
   iv) Stopband edge freqnecy : 1.3 rad/sec. **(10 Marks)**

6 a. A low pass filter is to the designed with the following desired frequency response

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

Determine the filter coefficients $h_d(n)$ and $h(n)$ if $w(n)$ is a rectangular window defined as follows : $W_R(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0, & \text{otherwise} \end{cases}$

Also find the frequency response, H(w) of the resulting FIR filter. **(12 Marks)**

b. Write equations of any four different windows used in design of FIR filters. **(08 Marks)**

7 a. Derive the expression for the Bilinear transformation, to transform an analog filter to a digital filter, by trapezoidal rule and explain the mapping from s-plane to z-plane. **(10 Marks)**

b. Let $H_a(s) = \dfrac{b}{(s+a)^2 + b^2}$ be a causal second order analog transfer function. Show that the causal second order digital transfer function H(z) obtained from $H_a(s)$ through impulse invariance method is given by $H(z) = \dfrac{e^{-aT} \sin bT\, z^{-1}}{1 - 2e^{-aT} \cos bT\, z^{-1} + e^{-2aT} z^{-2}}$. Also find H(z) when

$H_a(s) = \dfrac{1}{s^2 + 2s + 2}$. **(10 Marks)**

8 a. Realize the linear phase FIR filter with impulse response $h(n) = (\tfrac{1}{2})^n [u(n) - u(n-4)]$ **(05 Marks)**

b. Obtain the direct form – I, direct form – II cascade and parallel form realizations for the following system.

$$y(n) = x(n) + \frac{1}{4}x(n-1) - \frac{1}{8}y(n-3) - \frac{1}{2}y(n-2) - y(n-1)$$ **(15 Marks)**

* * * * *