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10TE52

Fifth Semester B.E. Degree Examination, June/July 2019
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define DFT and establish the relationship between the Fourier series co-efficient of a continuous time signal and DFT. **(04 Marks)**

b. An program to find DFT of a complex valued sequence x(n) is given, how can this program be used to find IDFT of X(K). **(03 Marks)**

c. Find the N-point DFT of the sequence:
$x(n)=a.n$ for $0 \le n \le N-1$ **(07 Marks)**

d. If the time-domain expression:
$$W(n) = \frac{1}{2} + \frac{1}{2}\cos\left[\frac{2\pi}{N}\left(n - \frac{N}{2}\right)\right]$$
What is the DFT of the windowed sequence,
$y(n) = x(n).W(n)$
Express the answer in terms of X(K). **(06 Marks)**

2 a. For DFT pair shown, compute the values of the boxed quantities using appropriate properties:
$\{\boxed{x_0}, 3, -4, 0, 2\} \xleftrightarrow{DFT} \{5, \boxed{x_1}, -1.28\text{-}j3.49, \boxed{x_3}, 8.78\text{-}j1.4\}$ **(03 Marks)**

b. Consider the sequence $x_1(n) = \{0, 1, 2, 3, 4\}$, $x_2(n) = \{0, 1, 0, 0, 0\}$, $S(n) = \{1, 0, 0, 0, 0\}$ and this 5-point DFT's.
(i) Determine the sequence y(n) so that $Y(K) = X_1(K) \cdot X_2(K)$.
(ii) Is there a sequence $x_3(n)$ so that $S(K) = X_1(K) \cdot X_3(K)$ **(07 Marks)**

c. Two finite sequences x(n) = [x(0), x(1), x(2), x(3)] and h(n) = [h(0), h(1), h(2), h(3)] have DFT's given by:
$X(K) = DFT\{x(n)\} = \{1, j, -1, -j\}$
$H(K) = DFT\{h(n)\} = \{0, 1+j, 1, 1-j\}$
Using the properties of DFT, find the following :
(i) $X_1(K)=DFT\{h(0), -h(1), h(2), -h(3)\}$
(ii) $X_2(K)=DFT\{x(0), h(0), x(1), h(1), x(2), h(2), x(3), h(3)\}$ **(06 Marks)**

d. If $x(n) = \{1, 2, 0, 3, -2, 4, 7, 5\}$, evaluate the following : (i) $\sum_{K=0}^{7} X(K)$ (ii) $\sum_{K=0}^{7} |X(K)|^2$. **(04 Marks)**

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.

3 a. If we perform DFT of an N-length sequence six times, what will be the resulting sequence? **(03 Marks)**

b. Find the output y(n) of a filter whose impulse response
$h(n) = \{1, -1\}$ and
$x(n) = \{1, 1, 1, 1, 1, 3, 1, 1, 4, 2, 1, 1, 3, 1\}$
Using Overlap save method and 5-point circular convolution. **(08 Marks)**

c. Explain In-place computation? How many complex additions and multiplications are required for N = 16 points, if DFT is computed directly and if FFT is used. **(05 Marks)**

d. Compute DFT of the sequence, $x(n) = \cos\left(\frac{n\pi}{2}\right)$ where N = 4, using DIT-FFT algorithm. **(04 Marks)**

4 a. Mention any four differences between DIT and DIF-FFT algorithms. **(04 Marks)**

b. Given $x_1(n) = \left\{1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}\right\}$ and $x_2(n) = \{1, 1, 1, 1\}$.

(i) Compute DFT of $x_1(n)$ using DIT-FFT.
(ii) Compute DFT of $x_2(n)$ using DIF-FFT.
(iii) Using above results, compute $\circledast_N$ by IDIF-FFT. **(10 Marks)**

c. Consider the sequence $x(n) = u(n) - u(n-8)$, using chirp z-transform, determine the values $x(Z_0)$ and $X(Z_1)$, where $Z_0 = e^{j\frac{2\pi}{8}}$ and $Z_1 = e^{j\frac{4\pi}{8}}$. **(06 Marks)**

PART – B

5 a. An Butterworth low pass filter has to meet the following specifications:

(i) Passband gain, $K_P = -1$ dB @ $\Omega_P = 4$ rad/sec.
(ii) Stop band attenuation greater than or equal to 20 dB @ $\Omega_S = 8$ rad/sec.

Determine the transfer function $H_a(s)$ of the lowest-order Butterworth filter to meet the above specifications. **(10 Marks)**

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

(i) Passband ripple : ≤ 2 dB
(ii) Passband edge : 1 rad/sec
(iii) Stopband attenuation : ≥ 20 dB
(iv) Stop band edge : 1.3 rad/sec. **(10 Marks)**

6 a. Realize the following Transfer function,

$$H(z) = \left\{\frac{0.7 - 0.25z^{-1} - z^{-2}}{1 + 0.1z^{-1} - 0.72z^{-2}}\right\}$$

Using Direct form – I, Direct form – II and Cascade form's. **(12 Marks)**

b. The Coefficients of a 3-stage FIR lattice structure are given by $K_1 = 0.1$, $K_2 = 0.2$, $K_3 = 0.3$. Find the co-efficients of Direct form – I, FIR filter and draw its block diagram. **(08 Marks)**

7 a. An analog signal contain's frequencies upto 10 kHz. This signal is sampled @ 50 KHz. Design an FIR filter having a linear phase characteristics and a transition band of 5 kHz. The filter should provide minimum 50 dB attenuation at the end of transition band, with respect to Fig. Q7 (a). **(10 Marks)**

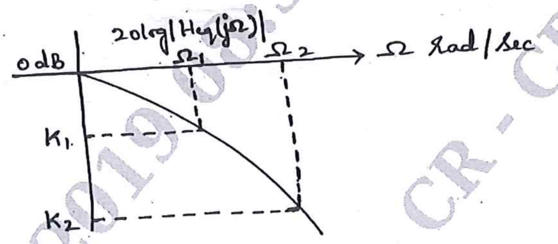

Fig. Q7 (a)

b. Design a 17-tap linear phase FIR filter with a cut-off frequency $W_C = \frac{\pi}{2}$. The design is to be done based on frequency sampling technique. **(10 Marks)**

8 a. An Digital IIR low pass filter is required to meet the following frequency-domain specifications:
Pass band ripple : ≤ 1 dB
Pass band edge frequency : $0.33\,\pi$ rad
Stop band attenuation : ≥ 40 dB
Stop band edge frequency : $0.5\,\pi$ rad
The digital filter is to be designed by applying Bilinear transformation on an analog system function. Determine the order, N of Butterworth and Chebyshev filter's needed to meet the specification's in the digital implementation. **(10 Marks)**

b. An 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. **(10 Marks)**

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