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10EC52

Fifth Semester B.E. Degree Examination, July/August 2021
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: ***1. Answer any FIVE full questions.***
2. Use of prototype tables are not permitted.

1 a. Derive the DFT expression from DTFT expression. **(05 Marks)**

b. If $x(n) = 1 \quad 0 \le n \le 5$
$= 0 \quad \text{elsewhere}$
and x(z) its z transform. If x(z) is sampled at $z = e^{j\frac{2\pi}{4}k} \quad 0 \le k \le 3$.
Find y(n) obtained as IDFT of x(k). **(07 Marks)**

c. Prove the following identities:

i) $W_N^{K+N} = W_N^K$ ii) $W_N^{K+\frac{N}{2}} = -W_N^K$

iii) DFT $(\delta(n)) = 1$ iv) $DFT[x^*(n)] = X^*(N-K)$ **(08 Marks)**

2 a. State and prove the time convolution property. **(06 Marks)**

b. Find the 4 point DFT of x(n) = 2.5, 1 - j2, -0.5, 1 + j0.5 using the matrix method. **(06 Marks)**

c. Let $X_p(n)$ be a periodic sequence with fundamental period N. Let $X_1(k)$ denote the N-point DFT of one period of $X_p(n)$ and $X_3(k)$ be the 3N point DFT of three periods of $X_p(n)$. What is the relationship between $X_1(k)$ and $X_3(k)$. **(08 Marks)**

3 a. Perform the linear convolution of the following sequences by overlap and add method.
x(n) = 1, -2, 3, 2, -3, 4, 3, -4….. and h(n) = 1, 2, -1
use 5 point circular convolution. Verify by the direct method of linear convolution. **(10 Marks)**

b. Calculate the number of complex multiplications and complex additions for N = 256 for both the direct DFT and FFT. **(05 Marks)**

c. Draw the basic Butterfly diagram of radix-2 DIT FFT and DIF-FFT. **(05 Marks)**

4 a. Given a sequence x(n) = 0, 1, 2, 3, 4, 5, 6, 7 determine X(k) using DIT FFT. Show the intermediate values. **(10 Marks)**

b. Compute the IDFT of the sequence X(k) = 12, 0, 0, 0, 4, 0, 0, 0 using DIF – FFT. **(10 Marks)**

5 a. Design an analog band pass filter to meet the following specifications:
i) $f_u = 20kHz \quad f_L = 50Hz$
ii) $k_p = -3.0103db$
iii) Stop band attenuation of atleast 20db at 20Hz and 45kHz. **(12 Marks)**

b. Find the order of the filter and pole locations for a Chebyshev analog low pass filter that has a 3db PB ripple cut-off of 100rad/sec and a stop band attenuation of 25db or greater for all radian frequencies past 250rad/sec. **(08 Marks)**

6 a. An LTI system is described by the equation $y(n) + 2y(n-1) - y(n-2) = x(n)$ determine the cascade and parallel realization. **(12 Marks)**

b. Determine the lattice co-efficients corresponding to the FIR system with system function $H(z) = 1 + \frac{7}{9}z^{-1} + \frac{3}{5}z^{-2}$ and realize it. **(08 Marks)**

7 a. The system function of the analog filter is given as $H_a(s) = \frac{s+0.1}{(s+0.1)^2+16}$ obtain the system function of the digital filter using bilinear transformation which is resonant at $w_r = \pi/2$. **(08 Marks)**

b. A Chebyshev filter of order 3 and unit band width has a pole at s = -1. Find the other two poles. The analog filter is mapped to the z domain using bilinear transformation with T = 2 find H(z). **(12 Marks)**

8 a. Compare FIR and IIR. **(05 Marks)**

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

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

determine the filter co-efficients h(n) if the window function is defined as

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

Also determine the frequency response $H(e^{jw})$ of the designed filter. **(15 Marks)**

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