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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 $x(n) = 1 \quad 0 \leq n \leq 5$ and $x(z)$ its z transform. If $x(z)$ is sampled at $z = e^{j\frac{2\pi}{4}k} \quad 0 \leq k \leq 3$.
 $= 0$ elsewhere
 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) $\text{DFT}(\delta(n)) = 1$ iv) $\text{DFT}[x^*(n)] = X^*(N-K)$ (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.
 $x(n) = 1, -2, 3, 2, -3, 4, 3, -4, \dots$ 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) $f_u = 20\text{kHz}$ $f_l = 50\text{Hz}$
 - ii) $k_p = -3.0103\text{db}$
 - 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 $\omega_r = \pi/2$. (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

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega} & -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4} \\ 0 & \frac{\pi}{4} \leq |\omega| \leq \pi \end{cases}$$

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

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

Also determine the frequency response $H(e^{j\omega})$ of the designed filter. (15 Marks)

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