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06EC52

Fifth Semester B.E. Degree Examination, December 2010

Digital Signal Processing

Time: 3 hrs. Max. Marks:100

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

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.

PART – A

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

b. A 498 point DFT of a real valued sequence x(n) has the following DFT samples given by : $X(0) = 2$, $X(11) = 7 + j3.1$, $X(K_1) = -2.2 - j1.5$, $X(112) = 3 + j0.7$, $X(K_2) = -4.7 + j1.9$, $X(249) = 2.9$, $X(309) = -4.7 - j\,1.9$, $X(K_3) = 3 - j0.7$, $X(412) = -2.2 + j1.5$ and $X(K_4) = 7 - j3.1$. The other samples have a value zero. Find the value of K_1, K_2, K_3 and K_4. **(05 Marks)**

c. Find the 4-point DFTs of the two sequences x(n) and y(n) using a single 4-point DFT :
$x(n) = (1, 2, 0, 1)$ $y(n) = (2, 2, 1, 1)$ **(10 Marks)**

2 a. Let $x_p(n)$ be a periodic sequence with fundamental period N. If the N point DFT $(x_p(n)) = X_1(K)$ and 3N point DFT $(xp(n)) = X_3(K)$:
i) Find the relationship between $X_1(K)$ and $X_3(K)$
ii) Verify the above result for {2, 1} and {2, 1, 2, 1, 2, 1} **(10 Marks)**

b. For the two sequences $x_1(n) = (2, 1, 1, 2)$ and $x_2(n) = (1, -1, -1, 1)$, compute the circular convolution using DFT and IDFT. **(10 Marks)**

3 a. Let $x(n) = (1, 2, 3, 4)$ with $X(K) = (10, -2+2j, -2, -2-2j)$. Find the DFT of $x_1(n) = (1, 0, 2, 0, 3, 0, 4, 0)$ without actually calculating the DFT. **(06 Marks)**

b. For : $\begin{cases} x(n) = 1 & 0 \le n \le 5, \\ \quad\;\; = 0 & \text{otherwise,} \end{cases}$

let X(Z) be the Z transform of x(n). If X(Z) is sampled at

$$Z = e^{j\left(\frac{2\pi}{4}\right)K} \qquad 0 \le K \le 3$$

Sketch y(n) obtained as IDFT of X(K). **(06 Marks)**

c. Derive the Radix-2 algorithm for DIT-FFT for N = 8. **(08 Marks)**

4 a. Find the 8 point DFT of {2, 1, 2, 1} using DIF – FFT. Draw the signal flow graph for N = 8 with intermediate values, Stuff appropriate zeros. **(10 Marks)**

b. Find the output y(n) of a filter whose impulse response is h(n) = (1, -2, 1) and input signal x(n) = 3, 1, -2, 1, -1, 2, 4, 3, 6. Use a 8 point circular convolution using overlap-add method. **(06 Marks)**

c. Compute the IDFT of X(K) = (2, 0, 2, 0) using DIT-FFT. Use a 4 point DFT. **(04 Marks)**

PART – B

5 a. Derive the expression for N order of the fifth and cut-off frequency Ω_c for a lowpass Butterworth filter starting from the frequency domain specifications of a lowpass filter. **(08 Marks)**

5 b. Design an IIR digital filter using bilinear transformation. Use Chebyshev prototype to satisfy the following specifications:
   i) LPF with –2 dB cut-off at 100 Hz
   ii) Stopband attenuation of 20 dB or greater at 500 Hz
   iii) Sampling rate of 4000 samples/sec. **(12 Marks)**

6 a. Design an analog bandpass filter to meet the following frequency domain specifications:
   i) –3.0103 dB upper and lower cut-off frequency of 50 Hz and 20 KHz.
   ii) A stopband attenuation of atleast 20 dB at 20 Hz and 45 KHz.
   iii) Monotonic frequency response. **(10 Marks)**

   b. Find the poles of the polynomial of order 5. Find $H_5(S)$ and gain at $\Omega = 1$ rad/sec in dB, for a Butterworth filter. **(10 Marks)**

7 a. List the steps in the design procedure of a FIR filter using window functions. **(06 Marks)**

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

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

   Determine the filter coefficients $h_d(n)$ and $h(n)$ if $W(n)$ is a rectangular window defined as :

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

   Also find the frequency response $H(\omega)$ of the FIR filter. **(10 Marks)**

   c. List the advantages and disadvantages of a FIR filter. **(04 Marks)**

8 a. Obtain the cascade and parallel form realization of :

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

(12 Marks)

   b. Realize the linear phase FIR filter having the following impulse response:

$$h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$$

(08 Marks)

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