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10EE64

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

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Compare 8-point DFT of a sequence $x(n) = (-1)^{nH}$, $0 \le n \le 7$. Also plot the magnitude of DFT. **(10 Marks)**

b. Explain the relationship between Z-transform and DFT. **(04 Marks)**

c. Let x(n) be the sequence, ie $x(n) = 2\delta(n) + \delta(n-1) + \delta(n-3)$. Find the sequence $y(n) = x(n)$ ⑤ $x(n)$, ie. 5-point circular convolution of x(n) with itself. **(06 Marks)**

2 a. State and prove linearity, time shift and frequency shift properties. **(10 Marks)**

b. A long sequence x(n) is filtered through a filter with impulse response h(n) to yield the output y(n). If $x(n) = \{1, 4, 3, 0, 7, 4, -7, -7, -1, 3, 4, 3\}$, $h(n) = \{1, 2\}$. Compute y(n) using overlap add technique. Use only a 5-point circular convolution. **(10 Marks)**

3 a. If $x(n) = \{1, 2, 0, 3, -2, 4, 7, 5\}$ evaluate the following : i) X(0) ii) X(4) iii) $\sum_{k=0}^{7} x(k)$ and iv) $\sum_{k=0}^{7} |x(k)|^2$. Show that x(0) is always real. **(06 Marks)**

b. What is the speed improvement factor in calculating 64-point DFT of a sequence using direct computation and FFT algorithm? Also mention the number of real registers required. **(04 Marks)**

c. Obtain the 8-point DFT of the following sequence using Radix – 2 DIF-FFT algorithm. $x(n) = \{2, 1, 2, 1\}$. Show all the results along signal flow graph. **(10 Marks)**

4 a. If $x_1(n) = \{1, 2, 0, 1\}$ and $x_2(n) = \{1, 3, 3, 1\}$, obtain $x_1(n)$ Ⓝ $x_2(x)$ by using DIT-FFT algorithm. **(10 Marks)**

b. Develop DIT-FFT algorithm for $N = 9 = 3 \times 3$ and draw the complete signal flow graph. **(10 Marks)**

PART – B

5 a. A third order Butterworth lowpass filter has the transfer function.

$$H(s) = \frac{1}{(s+1)(s^2+s+1)}$$. Design H(z) using impulse-invariant technique. **(08 Marks)**

b. 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)**

c. Compare IIT and BLT techniques. **(04 Marks)**

6 a. Design a digital Butterworth filter satisfying the following constraints using bilinear transform. Assume T = 1 sec.

$0.9 \le |H(e^{jw})| \le 1,\ 0 \le w \le \pi/2$;

$|H(e^{jw})| \le 0.2\ ,\ 3\pi/4 \le w \le \pi$. **(10 Marks)**

b. The system function of the first order normalized lowpass filter is $H(s) = \frac{3}{s+5}$. Obtain the system function of second order bandbass filter having passband from 1kHz to 3.5kHz. **(10 Marks)**

7 a. Design the bandpass linear phase FIR filter having cutoff frequencies of $W_{C_1} = 1$ rad/sample and $W_{C_2} = 2$ rad/sample. Obtain the unit sample response through following window:

$$w(n) = \begin{cases} 1 & \text{for} \quad 0 \le n \le 6 \\ 0 & \text{otherwise} \end{cases}$$

Also obtain the magnitude/frequency response. **(10 Marks)**

b. Determine the impulse response h(n) of a filter having desired frequency response,

$$H_d(e^{jw}) = \begin{cases} e^{\frac{-j(N-1)w}{2}} & \text{for } 0 \le |w| \le \pi/2 \\ 0 & \pi/2 \le |w \le \pi| \end{cases}$$

N = 7, use frequency sampling approach. **(10 Marks)**

8 a. Obtain the cascade realization of system function, $H(z) = 1 + \frac{5}{2}z^{-1} + 2z^{-2} + 2z^{-3}$. **(04 Marks)**

b. Realize a linear phase FIR filter having impulse response.

$h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$ **(04 Marks)**

c. Obtain the direct form – II, cascade and parallel form realization for the following system.

$y(n) = 0.75y(n-1) - 0.125\,y(n-2) + 6x(n) + 7x(n-1) + x(n-2)$. **(12 Marks)**

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