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2002 SCHEME EE55

Fifth Semester B.E. Degree Examination, June-July 2009

Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define DFT of x(n) and IDFT of X(K). Find 4-point DFT of $x(n) = \cos(\pi n/4)$ and IDFT of $X(K) = \{2, 0, 2, 0\}$. **(10 Marks)**

b. Find 4-point DFTs of $x(n) = \{1, 2, 1, 2\}$ and $h(n) = \{1, 0, 0, 0\}$. Therefrom, using linearity, find DFTs of $g(n) = \{4.2, 0.5, 0.20, 0.5\}$ and $f(n) = \{-3.8, 2, 1, 2\}$. **(10 Marks)**

2 a. X(K), Y(K) and G(K) are 6-point DFTs of x(n), y(n) and g(n) respectively. With $x(n) = \{0, 1, 2, 3, 4, 0\}$, find

i) y(n) if $Y(K) = W_2^{K} X(K)$, and

ii) g(n) if $G(K) = W_3^{2K} X(K)$ **(08 Marks)**

b. The sequence $x(n) = \{1, 1, 1, 1, 3, 1, 1, 4, 2, 1, 1, 3, 1, 1, 1\}$ is filtered through a filter with impulse response $h(n) = \{1, -1\}$. Compute the output of the filter y(n) using overlap-save method. Use 5-point circular convolution. **(12 Marks)**

3 a. Compute the 4-point DFTs of $g(n) = \{1, 0, 0, 1\}$ and $f(n) = \{0, 1, 1, 0\}$ using a single 4-point DFT computation. **(08 Marks)**

b. Use Radix-2 DIF algorithms for DFTs and DIT algorithm for IDFT to find the circular convolution $y(n) = x(n) \circledast h(n)$ if $x(n) = \{1, 1, 1, 1\}$ and $h(n) = \{1, 2, 3, 4\}$. **(12 Marks)**

4 a. Compute the 8-point DFT of

$$x(n) = \begin{cases} n & 0 \le n \le 7 \\ 0 & \text{Otherwise} \end{cases}$$

using radix-2 DIT FFT algorithm. Draw the corresponding SFG and label all variables according to your calculations. What is the speedup of this algorithm with respect to direct calculation? **(14 Marks)**

b. What are the salient features of DSP processors? **(06 Marks)**

5 a. Distinguish between the following:

i) Analog and Digital filters.

ii) IIR and FIR systems

iii) Recursive and Non-recursive structures. **(08 Marks)**

b. The transfer function of an IIR system is given by

$$H(z) = \frac{1 + \frac{1}{4}z^{-1}}{(1 + \frac{1}{2}z^{-1})(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2})}$$

Determine the block diagram representations of the system corresponding to (i) direct form (ii) canonic form (iii) cascade form and (iv) parallel form of realizations. **(12 Marks)**

6 a. Draw the frequency characteristics of direct Chebyshev and inverse Chebyshev filters and mark all salient points. Describe the procedural steps used to design a low pass direct Chebyshev digital filter. **(10 Marks)**

b. What is frequency transformation in the design of filters? The transfer function of a analog normalized LPF is $H(s) = \frac{1}{s^2 + s + 1}$. Using frequency transformation, determine

i) TF of a LPF of cutoff frequency 10 rad/sec.

ii) TF of a HPF of cutoff frequency 10 rad/sec. **(10 Marks)**

7 Define bilinear transformation. Use bilinear transformation to design a lowpass Butterworth digital filter to meet the following specifications:

i) –3 dB cutoff frequency of 0.5π rad.

ii) Stopband attenuation of at least 15 dB at 0.75π rad. **(20 Marks)**

8 a. Design a lowpass FIR filter to meet the following specifications:

i) Cutoff frequency = 500 Hz,

ii) Sampling frequency = 2000 Hz,

iii) Filter order = 10

iv) Filter length = 11. **(12 Marks)**

b. Represent the FIR system described by the impulse response $H(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$ in direct form and linear phase realization form. **(08 Marks)**