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B. Tech

CPEC 5302

Fifth Semester Examination – 2008

DIGITAL SIGNAL PROCESSING

Full Marks – 70

Time – 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. A signal is represented as : 2×10

$$x(n)=\begin{cases}1+\frac{n}{2}, & -2\le n\le -1\\ 1, & 0\le n\le 2\\ 0, & elsewhere\end{cases}$$

(a) Determine its values and sketch the signal $x(n)$.

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(b) Sketch the signal that results if $x(n)$ is first folded and then delayed by three samples.

(c) Express $x(n)$ in terms of $\delta(n)$.

(d) Sketch $x(-n+4)$.

(e) Give the direct form I realization of the equation defined as

$$y(n) = -a_1 y(n-1) + b_0 x(n) + b_1 x(n-1)$$

(f) State and prove the convolution property of the z-transform.

(g) What is the approximate transition width of main lobe in the rectangular window ? What happens to it if you double the filter length ?

(h) State and prove the circular time shift property of DFT.

(i) What is a periodogram ? What is its utility ?

(j) How may real multiplications and real additions are required for the computation of an N-point DFT ?

2. Find out the autocorrelation of the signal $x(n) = a^n u(n), 0 < a < 1$. Plot the resulting signal. When does the autocorrelated signal becomes the highest ? Why ? 6+2+1+1

3 (a) Compute the convolution $y(n)$ of two signals defined as $x_1(n) = \{2, -3, 2\}$ and

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$x_2(n) = \begin{cases} 1, 0 \le n \le 4 \\ 0, \text{ elsewhere} \end{cases}$. Plot $y(n)$. 6

(b) Determine the step response of the system $y(n) = ay(n-1) + x(n), -1 < a < 1$ with the initial condition $y(-1) = 1$. 4

4. (a). Find out the impulse response of the system

$y(n) = 0.7y(n-1) - 0.12y(n-2) + x(n-1) + x(n-2)$. Locate its poles and zeros. Is the system stable ? 6

(b) Compute the DFT of two sequences given as $x_1(n) = \left\{\underset{\uparrow}{1}, 2, 3, 2\right\}$ and $x_2(n) = \left\{\underset{\uparrow}{2}, 3, 4, 5\right\}$. Plot it. 4

5. (a) Determine the cascade realization of the system described by the following transfer function

$$H(z) = \frac{10(1-0.5z^{-1})(1-0.66z^{-1})(1+2z^{-1})}{(1-0.75z^{-1})(1-0.125z^{-1})\left[1-(0.5+j0.5)z^{-1}\right]\left[1-(0.5-j0.5)z^{-1}\right]}$$

6

(b) Compute the sequence $y(n)$ obtained by passing $x(n)\left\{\underset{\uparrow}{1}, 2, 3, 4\right\}$ through a FIR filter with impulse response $h(n) = \{1,2,1\}$. Consider a 4-point DFT. 4

6. (a) Bring out the mapping between ω and Ω. Where it is used ? 5

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(b) Design a single pole low pass digital filter with a 3-dB bandwidth of 0.3π by use of the bilinear transformation applied to the analog filter $H(s) = \frac{\Omega_c}{s + \Omega_c}$ where Ω_c is the 3-dB bandwidth of the analog filter. 5

7. Design an FIR linear phase digital filter by approximating the ideal frequency response

$$H_d(\omega) = \begin{cases} 1, |\omega| \le \frac{\pi}{6} \\ 0, \frac{\pi}{6} < |\omega| \le \pi \end{cases}$$

(a) Determine the coefficients of a 21-tap filter based on the window method with a rectangular window. 5

(b) Determine the magnitude response of the filter. 5

8. Describe the nonparametric method of power spectrum estimate. 10

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