Total No. of Questions : 8] [Total No. of Printed Pages : 4

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EC–603(N)

B. E. (Sixth Semester) EXAMINATION, June, 2011

(Electronics & Communication Engg. Branch)

DIGITAL SIGNAL PROCESSING

[EC–603(N)]

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Attempt any *five* questions. All questions carry equal marks. Make suitable assumptions wherever necessary.

1. (a) Determine if the system described by the following input-output equations are linear or non-linear :

   (i) $y(n) = n\,x(n)$

   (ii) $y(n) = A\,x(n) + B$

   (iii) $y(n) = e^{x}(n)$

   (b) Determine the response $y(n), n \geq 0$, of the system described by the second order difference equation :

   $$y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$$

   when the input sequence is :

   $$x(n) = 4^{n}\,u(n)$$

P. T. O.

2. (a) Determine the impulse response for the cascade of two linear time-invariant systems having impulse responses :

$$h_1(n) = \left(\frac{1}{2}\right)^2 u(n)$$

and

$$h_2(n) = \left(\frac{1}{4}\right)^2 u(n)$$

(b) Compute the convolution $x(n)$ of the signals :

$$x_1(n) = \{1, -2, 1\}$$

$$x_2(n) = \begin{cases} 1, & 0 \le n \le 5 \\ 0, & \text{elsewhere} \end{cases}$$

3. (a) Determine the z-transform of the following :

(i) $x(n) = n\,a^n\,u(n)$

(ii) $x(n) = \begin{cases} 1, & 0 \le n \le N-1 \\ 0, & \text{elsewhere} \end{cases}$

(iii) $x(n) = u(-n)$

(b) Determine the inverse z-transform of the following :

(i) $\log(1 + az^{-1}) \quad |z| \ge |a|$

(ii) $\dfrac{1}{1 - az^{-1}} \quad |z| > |a|$

4. (a) Determine the causal signal whose z-transform is given by :

$$X(z) = \frac{1 + z^{-1}}{1 - z^{-1} + 0{\cdot}5z^{-2}}$$

(b) Compute the response of the system :

$$y(n) = 0{\cdot}7\,y(n-1) - 0{\cdot}12\,y(n-2) + x(n-1) + x(n-2)$$

to the input $x(n) = n\,u(n)$. Is the system stable ?

5. (a) A linear time invariant system is described by the following difference equation :

$$y(n) = a\,y(n-1) + b\,x(n) \quad 0 < a < 1$$

(i) Determine the magnitude and phase of the frequency response H (ω) of the system.

(ii) Choose the parameter b so that the maximum value of $|\,H(\omega)\,|$ is unity and sketch $|\,H(\omega)\,|$ and $\angle\,H(\omega)$ for $a = 0{\cdot}9$.

(iii) Determine the output of the system to the input signal :

$$x(n) = 5 + 12\sin\frac{\pi}{2}n - 20\cos\left(\pi n + \frac{\pi}{4}\right)$$

(b) By means of the DFT and TDFT, determine the response of the FIR filter with impulse response

$$h(n) = \{\underset{\uparrow}{1}, 2, 3\}$$

to the input sequence

$$x(n) = \{\underset{\uparrow}{1}, 2, 2, 1\}$$

6. (a) Distinguish between Decimation-in-time and Decimation-in-frequency algorithms.

(b) Derive the signal flow graph for the N = 16 point, radix-4 decimation-in-time FFT algorithm in which the input sequence is in normal order and the computations are done in place.

7. (a) Design the least-square FIR inverse of length 2 to the system with impulse response :

$$h(n) = \begin{cases} -a, & n = 0 \\ 1, & n = 1 \\ 0, & \text{otherwise} \end{cases}$$

where $|\,a\,| < 1$.

P. T. O.

(b) What are the desirable features of finite response (FIR) digital filters ? Mention some of its drawbacks. What is the reasons that FIR filters are always stable ?

8. Write short notes on any *three* of the following :

(a) Linear phase FIR filters using windows

(b) Radix-2 FFT algorithm

(c) Properties of the z-transform

(d) Causal and non-causal system