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NEW SCHEME

Third Semester B.E. Degree Examination, July 2006

EE / EC /IT /TC / BM /ML

Signals & Systems

Time: 3 hrs.] [Max. Marks:100

Note: 1. *Answer any FIVE full questions.*

1 a. Write the formal definition of a signal and a system. With neat sketches for illustration, briefly describe the five commonly used methods of classifying signals based on different features. **(12 Marks)**

b. Determine if the following systems are time-invariant or time variant :

i) $y(n) = x(n) + x(n-1)$, ii) $y(n) = x(-n)$ **(04 Marks)**

c. Determine if the system described by the following equations are causal or non-causal :

i) $y(n) = x(n) + \dfrac{1}{x(n-1)}$, ii) $y(n) = x(n^2)$ **(04 Marks)**

2 a. What do you mean by impulse response of an LTI system? How can the above be interpreted? Starting from fundamentals, deduce the equation for the response of an LTI system, if the input sequence *x(n)* and the impulse response are given. **(06 Marks)**

b. Determine $y(n)$ if $x(n) = n+2$ for $0 \le n \le 3$ and

$h(n) = a^n u(n)$ for all n. **(07 Marks)**

c. Determine the convolution sum of the two sequences,

$x(n) = \{\underset{\uparrow}{3}, 2, 1, 2\}$ and $h(n) = \{1, \underset{\uparrow}{2}, 1, 2\}$ **(07 Marks)**

3 a. Discuss briefly the block diagram description for LTI systems by difference equations. **(06 Marks)**

b. What do you mean by natural response of a system? Determine the natural response for the system described by the following difference equations:

i) $y(n) - \dfrac{9}{16} y(n-2) = x(n-1)$, $y(-1) = 1$, $y(-2) = -1$.

ii) $y(n) + \dfrac{9}{16} y(n-2) = x(n-1)$, $y(-1) = 1$, $y(-2) = -1$. **(09 Marks)**

c. Find difference-equation descriptions for the two systems depicted in figure Q3 (c). **(05 Marks)**

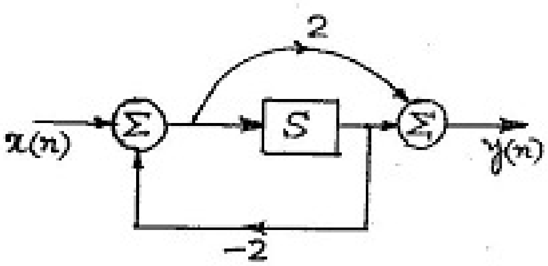

Fig. Q3 (c)-1

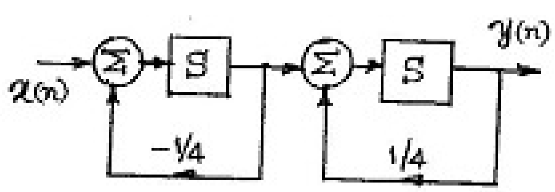

Fig. Q3 (c)-2

Contd....2

4 a. Write the equation which describes the discrete-time periodic sequence $x(n)$ in terms of the discrete-time Fourier series (DTFS) coefficients. Explain quantitatively, the computation of the DTFS coefficients. **(06 Marks)**

b. Use the defining equation for the DTFS coefficients to evaluate the DTFS representation for the signal $x(n)$ defined as,

$$x(n) = \cos\left[\frac{6\pi}{13}n + \frac{\pi}{6}\right]$$

Sketch the magnitude and phase spectra. **(07 Marks)**

c. Determine the FS representation for the signal $x(t)$ of fundamental period T given by,

$$x(t) = 3\cos\left[\frac{\pi}{2}t + \frac{\pi}{4}\right]$$

Sketch the magnitude and phase of X(K). **(07 Marks)**

5 a. Discuss the effects of a time shift and a frequency shift on the Fourier representation. **(06 Marks)**

b. Use the equation describing the DTFT representation to determine the time-domain signals corresponding to the following DTFTs :

i) $X(e^{j\Omega}) = \cos(\Omega + j\sin\Omega)$

ii) $X(e^{j\Omega}) = \begin{cases} 1 & \frac{\pi}{2} < |\Omega| < \pi \\ 0 & \textit{otherwise} \end{cases}$

$\arg\{X(e^{j\Omega})\} = -4\Omega$. **(07 Marks)**

c. Use the defining equation for the FT to evaluate the frequency-domain representations for the following signals :

i) $x(t) = e^{-3t}u(t-1)$, ii) $x(t) = e^{-|t|}$

Sketch the magnitude and phase spectra. **(07 Marks)**

6 a. A discrete-time system has a unit sample response $h(n)$ given by,

$$h(n) = \frac{1}{2}\delta(n) + \delta(n-1) + \frac{1}{2}\delta(n-2).$$

Find the system frequency response $H(e^{j\omega})$. Plot the magnitude and the phase response. **(09 Marks)**

b. Illustrate with neat sketches, the mathematical representation of sampling as the product of a given time signal and an impulse train. Suppose that you are given a signal $x(t)$, whose frequency content lies within the frequency band $-W < \omega < W$ as shown in figure Q6 (b). Draw the spectrum of the sampled signal when $\omega_s = 3$ W, $\omega_s = 2$ W, and $\omega_s = \frac{3}{2}$ W, where ω_s is the sampling frequency. **(06 Marks)**

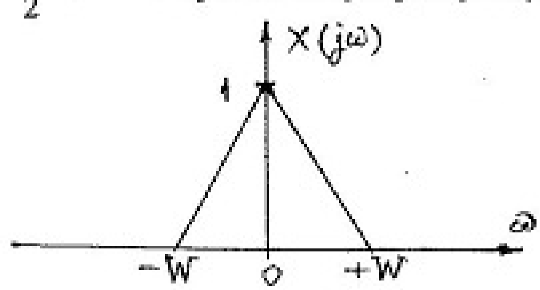

Fig. Q6 (b)

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c. An analog signal is given below as,

$$m(t) = 4\cos 100\pi t\,.$$

Calculate – i) the minimum sampling rate to avoid aliasing.

ii) if the signal is sampled at the rate of 200 Hz,

what is the discrete-time signal after sampling?

(05 Marks)

7 a. Write the definition of the Z-transform of a discrete-time signal *x(t)*. What do you mean by region of convergence? Write the important properties of the ROC of the Z- transform.

(09 Marks)

b. Find the Z-transform of –

i) $x(n) = n^2 u(n)$, ii) $x(n) = \cos n\theta . u(n)$

(06 Marks)

c. Find x(n) by using the convolution for

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

(05 Marks)

8 a. Using long division, determine the inverse Z-transform of

$$X(Z) = \frac{1}{\left[1-\left(\frac{3}{2}\right)Z^{-1}+\left(\frac{1}{2}\right)Z^{-2}\right]}$$

when the region of convergence is $|Z| > 1$.

(04 Marks)

b. By using partial fraction expansion method, find the inverse Z-transform of

$$H(Z) = \left[\frac{-4+8Z^{-1}}{1+6Z^{-1}+8Z^{-2}}\right]$$

(04 Marks)

c. i) Find the impulse response for the causal system,

$$y(n) - y(n-1) = x(n) + x(n-1)$$

ii) Find the response of the system to inputs $x(n) = u(n)$ and $x(n) = 2^{-n}.u(n)$. Test its stability.

(12 Marks)

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