(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 3082 **Roll No.** | | | | | | | | | | |

B.Tech.

FOURTH SEMESTER EXAMINATION, 2005-2006

SIGNALS AND SYSTEMS

Time : 3 Hours *Total Marks : 100*

Note : *(i)* *Attempt **ALL** questions.*

(ii) *All questions carry equal marks.*

(iii) *In case of numerical problems assume data wherever not provided.*

(iv) *Be precise in your answer.*

1. Attempt ***any four*** parts of the following : **(5x4=20)**

(a) Determine whether or not the signals below are periodic and, for each signal that is periodic, determine the fundamental period :

(i) $x[n] = R_e\{e^{jn\pi/12}\} + I_m\ \{e^{jn\pi/18})$

(ii) $x[n] = \sin\ (\pi + 0.2n)$

(iii) $x[n] = e^{\frac{j\pi}{16}n}\ \cos\ (n\pi/17)$

(b) Consider the discrete-time signal

$$x(n) = 1 - \sum_{R=3}^{\infty} \delta[n-1-k]$$

Determine the values of integer M and n_o so that $x[n]$ may be expressed as :

$$x[n] = u[M_n - n_o]$$

(c) Find the even and odd parts of the following signals :

(i) $x[n] = u[n]$

(ii) $x[n] = \propto^n u(n)$

(d) Consider a discrete-time system with input $x[n]$ and output $y[n]$. The input-output relationship for this system is :

$$y[n] = x[n]x[n-2]$$

(i) Is the system memory less ?

(ii) Determine the output of the system when the input is $A\delta[n]$, where A is any real or complex number.

(e) Consider the cascade of two systems S_1 and S_2 [Refer to Fig. 1 (e)]

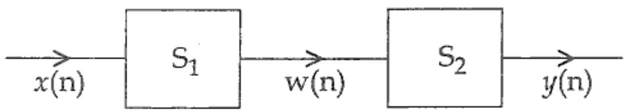

Figure : 1 (e)

(i) If both S_1 and S_2 are linear, shift-invarient, stable and causal, will the cascade also be linear, shift-invarient, stable and causal ?

(ii) If both S_1 and S_2 are non-linear, will the cascade be non-linear ?

(iii) If both S_1 and S_2 are shift-varying, will the cascade be shift varying ?

(f) Consider a system described by the difference equation,

$$y[n] - y[n-1] + 0.25y[n-2] = x[n] - 0.25x[n-1]$$

(i) Find the unit sample response of the system.

(ii) Find the response of the system to $x[n] = (0.25)^n u[n]$.

2. Attempt *any four* parts of the following : **(5x4=20)**

(a) Determine the Fourier Transform of the following signals :

(i) $x(t) = t\, e^{-at} u(t)$

(ii) $x(t) = \sin \omega_o t \cos \omega_o t$

(b) Determine the Fourier Transform of following discrete time signals.

(i) $x[n] = a^{-n}\, u(-n), \; |a|>1$

(ii) $x[n] = \begin{cases} 1, & |n| \le N_1 \\ 0, & |n| > N_1 \end{cases}$

(c) Discuss with an example the convolution property of continuous time Fourier transform. Also give the physical significance of convolutional property of CTFT.

(d) When the impulse train

$$x[n] = \sum_{K=-\infty}^{\infty} \delta[n-4k]$$

is the input to a particular LTI system with frequency response $H(e^{j\omega})$, the output of the system is found to be $y[n] = \cos\left[\frac{5\pi}{2} n + \frac{\pi}{4}\right]$.

(e) Find the inverse of the Discrete time Fourier transform shown in figure 2 (e).

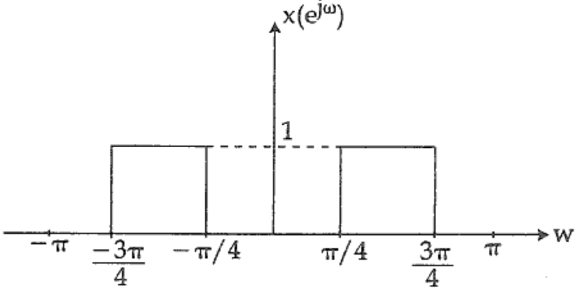

Figure 2 (e)

(f) Show that if $x(e^{j\omega})$ is real and even, $x[n]$ is real and even.

3. Attempt *any two* parts of the following : (10x2=20)

(a) Discuss magnitude and phase representation of the frequency response of continuous time and discrete time LTI systems. Define and discuss group delay.

(b) Consider a continuous time ideal bandpass filter whose frequency response is :

$$H(j\omega) = \begin{cases} 1, & \omega_c \le |\omega| \le 3\,\omega_c \\ 0, & \text{elsewhere} \end{cases}$$

(i) If h(t) is impulse response, determine the function g(t) such that :

$$h(t) = \left(\frac{\sin \omega_c t}{\pi t}\right) g(t)$$

(ii) As ω_c is increased, does the impulse response of the filter get more concentrated or less concentrated about the origin ?

(c) We have two discrete-time LTI systems with frequency responses,

$$H_1(e^{j\omega}) = \frac{1 + \frac{1}{2}e^{-j\omega}}{1 + \frac{1}{4}e^{-j\omega}}$$

$$H_2(e^{j\omega}) = \frac{\frac{1}{2} + e^{-j\omega}}{1 + \frac{1}{4}e^{-j\omega}}$$

Show that both of these frequency responses have the same magnitude function [ie $|H_1(e^{j\omega})| = |H_2(e^{j\omega})|$] but the group delay of $H_2(e^{j\omega})$ is greater than the group delay of $H_1(e^{j\omega})$ for $\omega > o$.

4. Attempt *any two* parts of the following : (10x2=20)

(a) Answer the following :

(i) Define the following terms :

(1) Nequist rate

(2) Sampling rate

(3) Under, critical and over sampling

(ii) What is aliasing phenomenon ? How can aliasing phenomenon be determinated ?

(iii) Determine the Nequist rate of the following signal : $x(t) = 1 + \cos(2 \times 10^3 \pi t) + \sin(4 \times 10^3 \pi t)$.

(b) Determine whether each of the following statements is true or false :

(i) The signal $x(t) = u(t + T_o) - u(t - T_o)$ can undergo impulse train sampling without aliasing provided that the sampling period $T < 2T_o$.

(ii) The signal $x(t)$ with fourier transform $x(j\omega) = u(\omega + \omega_o) - u(\omega - \omega_o)$ can undergo impulse train sampling without aliasing provided that the sampling period $T < \frac{2\pi}{\omega_o}$.

(c) Determine the Laplace transform and the associated region of convergence and pole-zero plot for each of the following function of time :

(i) $x(t) = e^{-2t}u(t) + e^{-3t}u(t)$

(ii) $x(t) = t\ e^{-2|t|}$

(iii) $x(t) = \delta(3t) + u(3t)$

5. Attempt *any two* parts of the following : **(10x2=20)**

(a) Find the z-transform of each of the following sequence :

(i) $x[n]=3\delta[n]+\delta[n-2]+\delta[n+2]$

(ii) $x[n]=\cos(n\omega_o)\ u[n]$

(iii) $x(n)=\left(\frac{1}{2}\right)^n u[n+2]+(3)^n u[-n-1]$

(b) Answer the following :

(i) What do you mean by region of convergence for the z-transform ? What are the various configurations of ROCs for the z-transform ?

(ii) What is inverse z-transform ? Discuss the various methods of inverse z-transformation.

(iii) Define the unilateral z-transform and discuss its special properties.

(c) Evaluate the convolution of the two sequences $h[n]=(0.5)^n\ 4[n]$ and $x[n]=3^n\ 4[-n]$

** *** **