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No. of Printed Pages—5 **EC–402**

B. TECH.

FOURTH SEMESTER EXAMINATION, 2003-2004

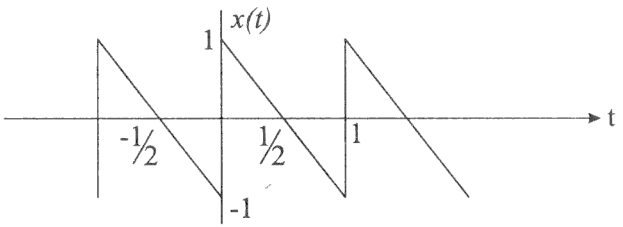
SIGNALS AND SYSTEMS

Time : 3 Hours *Total Marks : 100*

Note : Attempt **ALL** questions.

1. Attempt any *FOUR* of the following :— **(5×4)**

(a) Find the fundamental period T, the fundamental frequency ω_0 and the Fourier series coefficient a_k of the following periodic signal $x(t)$:—



(b) Compute the DFT of the four-point sequence :

$$x(n) = (0\,;\,1\,;\,2\,;\,3).$$

(c) Show that if a discrete LTI system $h(n)$ is subjected to input sequence $x(n)$, then its response $y(n)$ is represented as :

$$y(n) = x(n) * h(n).$$

(d) Show that

(i) $\delta(n) = U(n) - U(n-1)$

(ii) $u(n) = \sum_{k=0}^{\infty} \delta(n-k)$

(iii) Any signal can be decomposed into even and odd components. Explain with an example.

(e) Explain the Shift property and Duality property of Fourier series.

(f) Discuss the significance of :

(i) Impulse function,

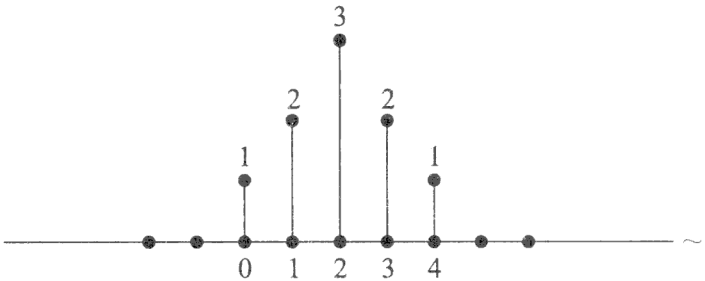
(ii) Unit step function,

(iii) Sinc function.

2. Attempt any *FOUR* of the following :— (5×4)

(a) A low pass digital filter with a sampling T = 50 μs has a cut off frequency 10 kHz. If the value of T in this filter changed to 25 μs, determine the new cut off frequency of the filter. Repeat the problem if T is changed to 100 μs.

(b) Consider a non-recursive filter with the impulse response shown in the figure. What is the group delay as a function of frequency for this filter ?



(c) What is understood by :

(i) Natural Response,

(ii) Forced response of a LTI system ? Explain with one appropriate example.

(d) Differentiate between :

(i) Ideal and Non-ideal filters,

(ii) IIR and FIR filters.

(e) Write the S domain transfer function of a first order system. Sketch and interpret its magnitude and phase response as a function of frequency.

(f) Find the convolution of the sequences :

$$x_1(n) = [1, \underset{\uparrow}{2}, 0] \; ; \quad x_2(n) = [2, \underset{\uparrow}{2}, 2]$$

3. Attempt any *TWO* of the following :— (10×2)

(a) The random processes $x(t)$ and $y(t)$ are defined as :

$$x(t) = V_1(t) + 3\,V_2(t - z)$$
$$y(t) = V_2(t + z) + 3\,V_1(t - z),$$

where $V_1(t)$ and $V_2(t)$ are independent white noise processes each with variance equal to 0·5. What are the autocorrelation functions of x and y ? Are these processes wide-sense stationary ?

(b) The independent random variables x and y have the probability densities :

$$f(x) = e^{-x} \; ; \qquad 0 \le x \le \infty$$
$$f(y) = 2\,e^{-2y} ; \quad 0 \le y \le \infty$$

Find and plot the probability density of the variable $z = x+y$.

(c) Explain the following terms :—

(i) Probability

(ii) Ergodic Process

(iii) Power spectral density of a random process

4. Attempt any *TWO* of the following :— (10×2)

(a) (I) Determine the Nyquist sampling rate and the Nyquist sampling interval for the following :—

(i) Sinc $(100\pi t)$ + Sinc $(50\pi t)$

(ii) Sinc $(50\pi t)$ Sinc $(100\pi t)$

(II) Explain Aliasing. What can be done to reduce aliasing ?

(b) What is understood by reconstruction of a continuous time signal from its samples known as interpolation ? How is this reconstruction accomplished and what are the practical difficulties ?

(c) Explain the following with reference to discrete time system :—

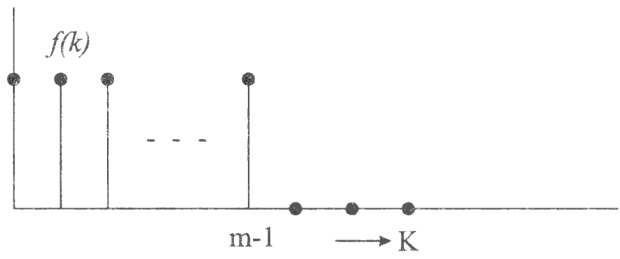
(i) Decimation or Down sampling

(ii) Interpolation or Up sampling

(iii) Time Shifting

5. Attempt any *TWO* of the following :— (10×2)

(a)



For the discrete time signal shown above, show that

$$F[Z]=\frac{1-Z^{-m}}{1-Z^{-1}}.$$

(b) (i) Find the transfer function of a Unit Delay.

(ii) Determine the system function for the causal LTI system with difference equation

$$y(n)-\frac{1}{2}y(n-1)+\frac{1}{4}y(n-2)=x(n).$$

(c) Explain the following with reference to z-transform :—

(i) Scaling property

(ii) Convolution property

(iii) Region of convergence of $F(Z)$

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