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

PAPER ID : 2500 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. VI) THEORY EXAMINATION 2010-11

FUNDAMENTALS OF DIGITAL SIGNAL PROCESSING

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **all** questions.

(2) All questions carry equal marks.

1. Answer any **four** of the following : **(5×4=20)**

(a) Find the even and odd parts of the signal $x(n) = u(n)$.

(b) A linear discrete-time system is characterized by its response $h_k(n)$ to a delayed unit sample $\delta(n-k)$. Determine whether or not the system $h_k(n) = \delta(2n-k)$ is shift-invariant.

(c) Find the DTFT of $\delta(n)$.

(d) State and prove the Periodicity and Symmetry properties of DFT.

(e) Find the convolution of the two signals :

$x(n) = a^n u(n)$

and $h(n) = u(n)$.

(f) How the Discrete Cosine Transform (DCT) is obtained from DFT ? Explain.

2. Attempt any **two** of the following : **(10×2=20)**

(a) Explain the discrete-time processing of analog signals.

(b) State and prove the sampling theorem. If the Nyquist rate for $x_a(t)$ is w_s, what will be the Nyquist rate for signal $\frac{dx_a(t)}{dt}$.

(c) (i) Write short note on multirate signal processing.

(ii) Consider the discrete-time sequence $x(n) = \cos\left(\frac{n\pi}{8}\right)$.

Find two different continuous-time signals that would produce the sequence when sampled at a frequency of $f_s = 10$ Hz.

3. Attempt any **two** of the following : **(10×2=20)**

(a) If the input to a linear shift-invariant system is

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

the output is

$$y(n) = 6\left(\frac{1}{2}\right)^n u(n) - 6\left(\frac{3}{4}\right)^n u(n)$$

Find the system function and determine whether or not the system is stable and/or causal. Also comment on the realizability of system.

(b) Evaluate the frequency response of the system described by the system function

$$H(z) = \frac{1}{1-0.8z^{-1}}$$

after deriving expression for frequency response of a system with a rational function.

(c) Comment on the following :

(i) Finite precision numerical effects

(ii) Effects of round-off noise in digital filters.

4. Attempt any **two** of the following : **(10×2=20)**

(a) Design a low-pass Butterworth filter having following specifications :

$$f_p = 6\text{ kHz},\ f_s = 10\text{ kHz},\ \delta_p = \delta_s = 0.1$$

(b) Use the window design method to design a minimum-order high-pass filter with a stopband cutoff frequency $w_s = 0.22\pi$, a passband cutoff frequency $w_p = 0.28\pi$, and a stopband ripple $\delta_s = 0.003$.

(c) Use the impulse invariance method to design a digital filter from an analog prototype that has a system function

$$Ha(s) = \frac{s+a}{(s+a)^2+b^2}$$

5. Attempt any **two** of the following : (10×2=20)

(a) Write notes on :

(i) Goertzel algorithm

(ii) Effect of finite register length.

(b) Compute the eight point DFT of the sequence :

$$x(n)=\begin{cases}1\ , & 0\le n\le 7\\ 0\ , & \text{otherwise}\end{cases}$$

by using the decimation-in-frequency FFT algorithm.

(c) How spectrum analysis of random signals are performed using estimates of the autocorrelation sequence ?