Printed Pages—4   **EEN011**

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

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(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 $x_s(t)$ is w_s, what will be the Nyquist rate for signal $\dfrac{dx_a(t)}{dt}$

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

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

          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)   Goeitzel 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 ?