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

PAPER ID : 3092   Roll No.

B. Tech.

(SEM. VI) EXAMINATION, 2006-07
DIGITAL SIGNAL PROCESSING

Time : 3 Hours]   *[Total Marks : 100*

Note :   *Attempt **all** questions.*

1   Attempt any **four** parts of the following

(a)   Compute the N-point DFT of each of the   5
following sequences :

(1) $x_1(n) = \delta(n - n_0)$ where $0 \le n_0 < N$

(2) $x_2(n) = \alpha^n$ $0 \le n < N$

(b)   State the circular shift property of DFT and   5
apply it to find inverse DFT of

$$Y(k) = e^{j2k}\left(\frac{2\pi}{10}\right)X(k).$$

(c)   Consider a sequence   5

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

(1)   Find the expression of DFT $X(k)$ is terms of k.

(2)   If $x(n)$ is circularly convolved with $X(n)$
itself what is $y(n) = x(n) \textcircled{4} x(n)$?

(d)   Let $x(n)$ be an N point sequence and let   5

$$w(n) = \frac{1}{2} + \frac{1}{2}\cos\left[\frac{2\pi}{N}\left(n - \frac{N}{2}\right)\right]$$ find the DFT

of $x(n)\,w(n)$ in terms of DFT of $x(n)$.

(e) State and prove the "circular convolution" **5** property of DFT.

(f) Find the linear convolution using circular **5** convolution of the following sequences :

$$x(n) = \{1, \ 2, \ 1\}, \quad h(n) = \{1, \ 2\}$$

2 Answer any **four** parts of the following : **5×4=20**

(a) Given an FFT program to find the N-point **5** DFT of a sequence, how may this program be used to find the inverse DFT ?

(b) Determine how a **2N** point DFT of a real **5** valued sequence may be computed using an N-point FFT algorithm.

(c) Draw the flow graph of an eight point **5** decimation - in -frequency algorithm and mention different expressions.

(d) Determine the four point DFT of the sequence **5**

$$x(n) = \{1, \ 0, \ 2, \ 1\} \text{ using decimation in time}$$

FFT algorithm.

(e) Explain how many the DFT of two real **5** sequences be efficiently computed ?

(f) Briefly explain Goertzal Algorithm for efficient **5** DFT computation.

3 Attempt any **two** parts of following :

(a) What are linear phase FIR filters ? How can **10** the symmetry of these filters help to simplify the network structure ? A linear phase filter has the following unit sample response :

$h_{(n)}$	$h_{(0)}$	$h_{(1)}$	$h_{(2)}$	$h_{(3)}$	$h_{(4)}$	$h_{(5)}$	$h_{(6)}$
$Value$	−0.01	0.02	−0.10	0.40	−0.10	0.02	−0.01

Draw the signal flow graph for this system that requires the minimum number of multiplications.

(b) Determine and draw the cascade and parallel **10** realizations for the system described by the system function :

$$H(z) = \frac{10\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{2}{3}z^{-1}\right)\left(1 - 2z^{-1}\right)}{\left(1 - \frac{3}{4}z^{-1}\right)\left(1 - \frac{1}{8}z^{-1}\right)\left(1 - z^{-1} + \frac{1}{2}z^{-2}\right)}$$

(c) Draw the direct-form structures of the **10** following system functions :

(1) $H_1(z) = \dfrac{1 + 2z^{-1} + z^{-2}}{1 - 0.75\,z^{-1} + 0.125\,z^{-2}}$

(2) $H_2(z) = 1 + 2.88z^{-1} + 3.404\,z^{-2}$

$\qquad\qquad + 1.74\,z^{-3} + 0.4z^{-4}$

4 Attempt any **two** parts of following : **2×10=20**

(a) Use the rectangular window to design a **10** linear phase FIR filter of order $N = 24$ to approximate the following frequency response magnitude -

$$\left|H_d(e^{jw})\right| = \begin{cases} 1, & |w| \le 0.2\pi \\ 0, & 0.2\pi \le |w| \le \pi \end{cases}$$

(b) Design an FIR filter to meet the following **10** specifications :

Passband edge = **2 kHz**

Stop band edge = **5 kHz**

Stop band attenuation = **42 dB**

Sampling frequency = **Fs = 20 kHz**

Use Hanning window.

(c)   Briefly explain frequency sampling method of **10** designing FIR filter. An FIR filter has the following symmetry in the impulse response :

$$h(n) = h(M - 1 - n) \text{ for } M \text{ odd}$$

Derive its frequency response and show that it has linear phase.

5   Attempt any **four** parts of following :   **5×4=20**

(a)   Design a filter for the following specifications : **5**
   (1)   Monotonic passband and stop band
   (2)   **−3.01 dB** cut off frequency of **0.5 π**
   (3)   Magnitude down at least **15 dB** at **0.75 π**

(b)   For the transfer function $H(s) = \dfrac{1}{s^2 + \sqrt{2}\, s + 1}$ **5**

   Find the corresponding system function $H(z)$ using bilinear transformation.

(c)   Show that bilinear transformation maps in   **5**

   $j\Omega$ axis in the s-plane into the unit circle,

   $|z| = 1$ and maps the left half s-plane

   $\mathbf{Re}(s) < 0$ inside the unit circle, $|z| < 1$

(d)   A continuous time filter has the system   **5**

   function $H(s) = \dfrac{1}{(s - k)^2}$, i.e. $H(s)$ is a

   second order pole at k, use the impulse-invariance method to design a digital filter.

(e)   Use bilinear transformation to convert low   **5**

   pass filter, $H(s) = \dfrac{1}{s^2 + \sqrt{2}\, s + 1}$ into a high

   pass filter with passband edge at **100 Hz** and

   $F_s = 1\,kHz$ (sampling frequency, F_s)

(f)   Describe the method to design IIR filters   **5** by approximation of derivatives.