T.E (Elect.) Sem-VII (Revised) 30/05/07
Signal Processing - II 3 to 6

D469 : 1st H'07

Con. 2695-07. (REVISED COURSE) ND-539

(3 Hours) [Total Marks : 100

N.B. (1) Question No. 1 is **compulsory**.
(2) Attempt in all **five** questions including Question No. 1.
(3) Figures to the right indicate **full** marks.

T.E (Elect) Sem VI Rev Digital Processing - II 30/5/07

1. (a) A system has an impulse response — 5

$$h(n) = (0.2)^n \cos\left(\frac{\pi n}{3}\right) \cdot u(n)$$

Plot poles and zeros.

(b) Given x(n) = { a, b, c, 1, 0, 1, c, b }. Can this sequence have X(k) as shown below ? 5
X(k) = { (2 + a + 2b + 2c), (3 + j 4), (2 + j0·5), (–3 + j 2), (2), (–3 + j 2), (2 + j 0·5), (3 + j 4) }
where a, b and c are real numbers. Justify your answer.

(c) Explain the effect of windowing operation on the desired frequency response. 5

(d) Obtain Cascade realization of the given system function using minimum number of multiplications. Note that the two sections have linear phase symmetry in their impulse responses. 5

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

2. (a) An FIR filter is described by the difference equation y(n) = x(n) + x(n – 10)
(i) Compute and sketch its magnitude and phase response 8
(ii) Determine its response to the input 2
$x(n) = 10 + 5\cos(2\pi\, n/5 + \pi/2), \quad -\infty < n < \infty.$

(b) Let $x_1(n)$ = { 1, 2, 3, 4 } and $x_2(n)$ = { 5, 6, 7, 8 }. Find $X_1(k)$ and $X_2(k)$ of the above sequences by performing DFT computation only once. 10

3. (a) Determine circular convolution and linear convolution using circular convolution of the following sequences : 10
$x_1(n)$ = { 4, 3, 2 }
$x_2(n)$ = { 1, 2, 1, 3, 4, 2 }.

(b) Using trapezoidal rule of integration show that —

$$S = \frac{2}{T}\frac{1 - Z^{1}}{1 + Z^{-1}} \quad \text{and} \quad \Omega = \frac{2}{T}\tan\left(W/2\right).$$

Where Ω is analog frequency and W is digital frequency ? What do you mean by non-linear warping ? 10

4. (a) Describe the four types of linear phase FIR filters and derive the conditions for having compulsory zeros at z = +1 or –1 for types 2, 3 and 4 linear phase systems. 10

(b) A digital low-pass filter is required to meet the following specifications :—

Pass band ripple	: ≤ 1 dB
Pass band edge	: 4 kHz
Stop band attenuation	: ≥ 40 dB
Stop band edge	: 6 kHz
Sampling rate	: 24 kHz

Find the order of Butterworth and Chebyshev filter using bilinear transformation.

[TURN OVER

Con. 2695-ND-539-07.

5. (a) The desired frequency response of a low-pass filter is — 10

$$H_d(e^{jw}) = e^{-3jw} \quad \text{for} \quad \frac{-3\pi}{4} \le w \le \frac{3\pi}{4}$$

$$= 0 \quad \text{otherwise}$$

Determine $H(e^{jw})$ for M = 7 using Blackman window.

(b) Find the inverse DTFT of $X(e^{jw}) = \delta(w)$ $-\pi < w \le \pi$. 4

(c) Consider the DFT pair $x(n) \xleftrightarrow{DFT} X_{DFT}(k)$ 6

Where $x(n) = \{ 1, 2, 1, 0 \}$ and

$X_{DFT}(k) = \{ 4, -j\,2, 0, j\,2 \}$

Find the DFT of —

(i) $y(n) = x(n - 2)$

(ii) $y(n) = x^*(n)$.

6. (a) Determine the impulse response for the Cascade of two linear time-invariant systems having impulse response. 10

$$h_1(n) = \left(\frac{1}{2}\right)^n u(n) \quad \text{and} \quad h_2(n) = \left(\frac{1}{4}\right)^n u(n).$$

Make use of convolution property to get the answer.

(b) Consider the causal linear shift-invariant filter with system function — 10

$$H(z) = \frac{1 + 0 \cdot 875\, z^{-1}}{\left(1 + 0 \cdot 2\, z^{-1} + 0 \cdot 9\, z^{-2}\right)\left(1 - 0 \cdot 7\, z^{-1}\right)}.$$

Draw a signal flow-graph for this system using —

(i) Direct form II

(ii) A Cascade of first order system realized in direct form II.

7. Write notes on the following :— 20

(a) DSP processors

(b) Properties of DFT

(c) Digital oscillator

(d) Linear FIR filtering of long data sequence using DFT.
