II sthalf-09-nkE-G 212

M.E. / Sem - I / (Rev) ETRX

Con. 5059-09. Discrete Time Signal Processing & Applications **BB-6107**

(LT) (3 Hours) [Total Marks : 100

7/12/09

N.B. : (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions of the remaining.

1. Solve any **four** questions of the following :— **20**
   (a) The impulse response of a relaxed LTI system is $h(n) = a^n u(n)$, for $|a| < 1$.
   Determine value of unit step response of this system as $n \to \infty$.
   (b) Given the sequences $x_1(n) = \{1, 2, 3, 1\}$ and $x_2(n) = \{4, 3, 2, 2\}$. Find $x_3(n)$ such that $X_3(K) = X_1(K) \cdot X_2(K)$.
   (c) Find 4-point DFT of a discrete-time sequence
   $$x(n) = \cos\left(\frac{n\pi}{2}\right) \text{ using DIT-FFT.}$$
   (d) Determine the steady-state response of the system,
   $$y(n) = \frac{1}{2}[x(n) - x(n-2)] \text{ to the input}$$
   $$x(n) = 5 + 3\cos\left(\frac{\pi n}{2} + 60^\circ\right) + 4\sin(\pi n + 45^\circ)\ -\infty < n < \infty.$$
   (e) State whether true or false and justify : The approximation of derivatives method of designing IIR digital filter is not suitable for designing highpass filters.

2. (a) The sequence $x(n) = 4\delta(n) + 3\delta(n-1) + 2\delta(n-2) + \delta(n-3)$ has 8-point DFT $X(k)$. **8**
   Determine the sequence—
   (i) $y(n)$ that has 8-point DFT $Y(K) = W_8^{4K} X(K)$ and
   (ii) $w(n)$ that has 8-point DFT $W(K) = 0{\cdot}5\,[X(K) + X(-K)]$ using DFT properties only.
   (b) Compute 8-point DFT of the following sequence using DIF-FFT. **12**
   $$x(n) = \begin{cases} 1 & 0 \le n \le 3 \\ 0 & 4 \le n \le 7 \end{cases}$$
   Knowing this result, compute the DFT of the sequence, $x_1(n) = \begin{cases} 1 & n = 0 \\ 0 & 1 \le n \le 4, \\ 1 & 5 \le n \le 7 \end{cases}$
   using DFT propertries only and not otherwise.

3. (a) Show that the energy of a real-valued energy signal is equal to the sum of the energies of its even and odd components. **5**
   (b) Evaluate the magnitude and phase response of the system **5**
   $$y(n) = x(n) + 0{\cdot}9x(n-2) - 0{\cdot}4y(n-2) \text{ at } \omega = 0, \frac{\pi}{2}, \pi.$$

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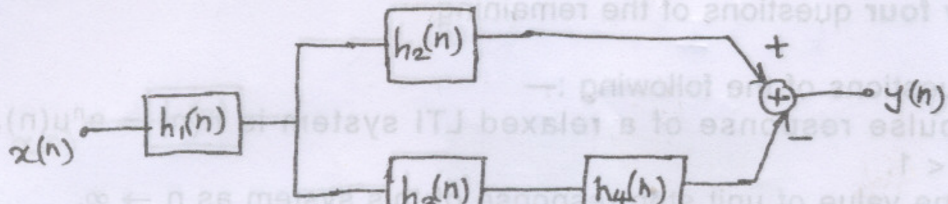
(c) Consider the interconnection of LTI systems as shown in following Figure. 10



If $h_1(n) = \left\{ \underset{\uparrow}{\frac{1}{2}}, \frac{1}{4}, \frac{1}{4} \right\}$, $h_2(n) = h_3(n) = (n+1)\,u(n)$ for $0 \le n \le 3$ and $h_4(n) = \delta(n-2)$ then determine the impulse response h(n) and the response of this system to the input, $x(n) = \delta(n+2) + 3\delta(n-1) - 4\delta(n-3)$.

4. (a) Determine the coefficients of a linear phase FIR filter having a symmetric impulse response and a frequency response that satisfies the conditions given below using Frequency Sampling method. 10

$$H\left(\frac{2\pi k}{15}\right) = \begin{cases} 1 \;; & k = 0, 1, 2, 3 \\ 0 \;; & k = 4, 5, 6, 7 \end{cases}$$

(b) Obtain the direct from I and direct form II realization the system given below. 10

$$y(n) = -0{\cdot}1y(n-1) + 0{\cdot}2y(n-2) + 3x(n) + 3{\cdot}6x(n-1) + 0{\cdot}6x(n-2)$$

5. (a) Design an equivalent digital filter from an analog filter using *impulse invariance method* if— 10

$$H(s) = \frac{4}{(s+1)\left(s^2+4s+5\right)}. \quad \text{Assume } T = 0{\cdot}5 \text{ sec}$$

(b) Starting from suitable Butterworth lowpass prototype filter, obtain digital bandpass filter using bilinear z-*transformation method*, satisfying specifications given below : 10

Pass band : 200 — 300 Hz, sampling frequency : 2 kHz, Filter order, N : 2.

6. Design a zero phase FIR lowpass filter using Kaiser Window Function to satisfy following specifications : $A_p \le 0{\cdot}1$ dB at 20 rad/sec and $A_s \ge 44$ dB for 30 rad/sec. 20

Assume sampling frequency of 100 rad/sec.

7. Design an analog filter using Butterworth, Chebyshev and inverse Chebyshev approximation to meet following specifications : 20

$A_p \le 1$ dB for $\Omega_p \le 4$ rad/s and $A_s \ge 20$ dB for $\Omega_s \ge 8$ rad/s.
