

M. E. / sem - I / (Rev) ETRx

Con. 5059-09. Discrete Time Signal Processing & Applications **BB-6107**
 (3 Hours) [Total Marks : 100]

LT

F/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 $n \rightarrow \infty$.

(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 $W(K) = 0.5 [X(K) + X(-K)]$ using DFT properties only.

(b) Compute 8-point DFT of the following sequence using DIF-FFT. **12**

$$x(n) = \begin{cases} 1 & 0 \leq n \leq 3 \\ 0 & 4 \leq n \leq 7 \end{cases}$$

Knowing this result, compute the DFT of the sequence, $x_1(n) = \begin{cases} 1 & n = 0 \\ 0 & 1 \leq n \leq 4, \\ 1 & 5 \leq n \leq 7 \end{cases}$

using DFT properties only and not otherwise.

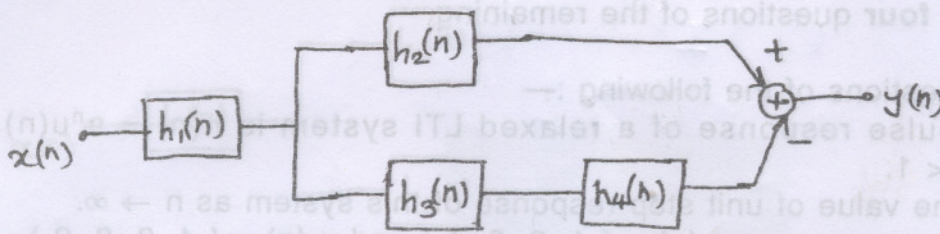
3. (a) Show that the energy of a real-valued energy signal is equal to the sum of the energies of its even and odd components. **5**

(b) Evaluate the magnitude and phase response of the system **5**

$$y(n) = x(n) + 0.9x(n-2) - 0.4y(n-2) \text{ at } \omega = 0, \frac{\pi}{2}, \pi.$$

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



If $h_1(n) = \left\{ \begin{matrix} \frac{1}{2}, & \frac{1}{4}, & \frac{1}{4} \\ \uparrow & & \end{matrix} \right\}$, $h_2(n) = h_3(n) = (n + 1) u(n)$ for $0 \leq n \leq 3$ 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 form I and direct form II realization the system given below. 10
- $$y(n] = -0.1y[n-1] + 0.2y[n-2] + 3x[n] + 3.6x[n-1] + 0.6x[n-2]$$

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

$$H(s) = \frac{4}{(s+1)(s^2+4s+5)}. \text{ Assume } T = 0.5 \text{ sec}$$

- (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 : $A_p \leq 0.1$ dB at 20 rad/sec and $A_s \geq 44$ 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

$$A_p \leq 1 \text{ dB for } \Omega_p \leq 4 \text{ rad/s and } A_s \geq 20 \text{ dB for } \Omega_s \geq 8 \text{ rad/s.}$$