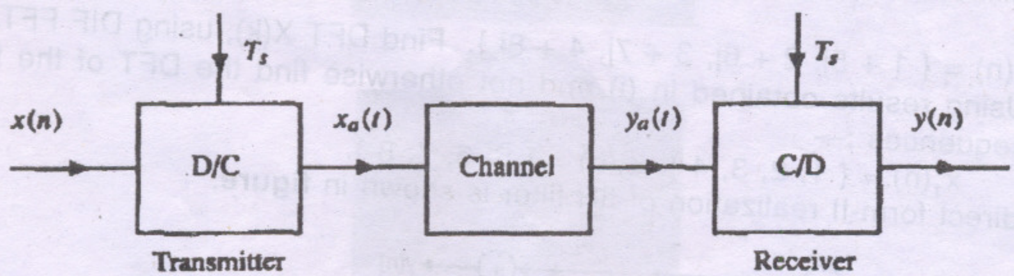
TIIndHF1208 B.E. Sem 7 (Rev.) EXTC Discrete Time Signal Processing 04/12/08

Con. 5422-08. **(REVISED COURSE)** **RC-7319**

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

N.B. (1) Question No. **1** is **compulsory.**
(2) Attempt any **four** questions out of remaining **six** questions.
(3) Assume **suitable** data if **required**.

1. (a) A digital sequence x(n) is to be transmitted across a linear time-invariant band limited channel as illustrated in **figure**. **20**



The transmitter is a D/C converter, and the receiver simply samples the received waveform $y_a(t)$.

$$y(n) = y_a(nT_s)$$

Assume that the channel may be modeled as an ideal low-pass filter with a cutoff frequency of 4 kHz :—

$$G_a(j\Omega) = \begin{cases} 1 & |\Omega| \le 2\pi(4000) \\ 0 & |\Omega| > 2\pi(4000) \end{cases}$$

Assuming an ideal C/D and D/C , and perfect synchronization between the transmitter and receiver, what values of sampling period, T_s will guarantee that y(n) = x(n).

(b) We can create a comb filter by taking an FIR filter and replacing z by z^L, where L is a positive integer. Justify.

(c) Explain how to determine IDFT using FFT algorithm.

(d) Compare Impulse invariant and Bilinear transformation.

2. (a) Find a difference equation to implement a filter that has a unit sample response. **8**

$$h(n) = \left(\frac{1}{4}\right)^n \cos\left(\frac{n\pi}{3}\right) u(n).$$

(b) Design a digital resonator with a peak gain of unity at 50 Hz and 3 dB bandwidth of 6Hz assuming a sampling frequency of 300Hz. **6**

(c) Realize a digital sinusoidal generator with the help of block diagram. **6**

3. (a) A signal $x(t)$ that is bandlimited to 10 kHz is sampled with a sampling frequency of 20 kHz. The DFT of $N = 1000$ samples of $x(n)$ is then computed. 10

(i) To what analog frequency does the index $k = 150$ correspond ?

(ii) What is the spacing between the spectral samples ?

(b) The linear phase constraint on FIR filters places constraints on the unit sample response and the location of the zeros of the system function. In the table below, indicate with a check which filter types could successfully be used to approximate the given filter type. Justify your answers. 10

	Type I	Type II	Type III	Type IV
Low-pass filter				
High-pass filter				
Bandpass filter				
Bandstop filter				
Differentiator				

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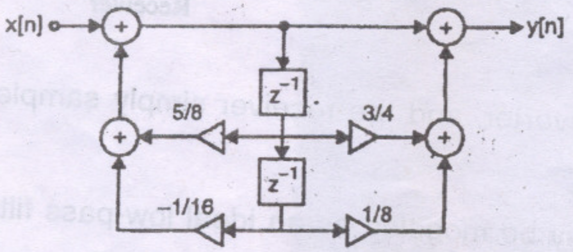
4. (a) What is DCT ? Explain how DCT is classified in four types as DCT-I, DCT-II, DCT-III and DCT-IV. Which type is mostly used and why ? 10
   (b) Design a digital Chebyschev filter to satisfy the constraints, 10

$$0.707 \le \left| H(e^{j\omega}) \right| \le 1, \qquad 0 \le \omega \le 0.2\,\pi$$

$$\left| H(e^{j\omega}) \right| \le 0.1, \qquad 0.5 \le \omega \le \pi$$

   Use bilinear transformation and assuming T = 1 sec.

5. (a) (i) $x(n) = \{ 1 + 5j, 2 + 6j, 3 + 7j, 4 + 8j \}$. Find DFT X(k), using DIF FFT. 8
   (ii) Using results obtained in (i) and not otherwise find the DFT of the following sequences :—
   $x_1(n) = \{ 1, 2, 3, 4 \}$, $x_2(n) = \{ 5, 6, 7, 8 \}$.
   (b) The direct form-II realization of IIR filter is shown in **figure**. 12



   (i) Obtain transfer function H(z).
   (ii) Obtain difference equation.
   (iii) Realize the filter using cascade form with first order sections.
   (iv) Realize the filter using parallel form with first order sections.
   (v) Find impulse response of the filter.
   (vi) Draw pole zero diagram.
   (vii) Comment on stability of filter.

6. (a) Design FIR filter to satisfy following specifications :— 10
   Passband edge frequency 1·5 kHz
   Transition width 0·5 kHz
   Stopband attenuation 750 dB
   Sampling frequency 8 kHz
   Use Hamming window function.
   (b) With the help of block diagram, explain TMS 32 C 5X series of processors. 10

7. Write short notes on the following :— 20
   (a) Filtering of long data sequences
   (b) Finite word length effects in digital filters
   (c) Geortzel's Algorithm
   (d) Compare the DSP processors and general purpose processors.