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

Paper ID : 131661 Roll No. | | | | | | | | | | |

B.TECH.

Theory Examination (Semester-VI) 2015-16

DIGITAL SIGNAL PROCESSING

Time : 3 Hours *Max. Marks : 100*

Section-A

1. **Attempt all parts. All parts carry equal marks. Write answer of each part in short.** (2×10 = 20)

 (a) What is Discrete Time Fourier Transform and How it is related to Discrete Fourier Transform?

 (b) Establish the relation between Z-transform and DFT.

 (c) What is zero padding? What are its uses?

 (d) Calculate number of multiplications needed in calculation of DFT and FFT of 32 point sequence and also calculate speed improvement factor.

 (e) Explain Bit- reversal and In-place computation.

(f) How an IIR filter is different than FIR filter?

(g) Compute X(0) if X(K) is 4-point DFT of the following sequence

$$x(n) = \{1,0,-1,0\}$$

(h) For the given system function,

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

Obtain Cascade realization with minimum number of multipliers.

(i) What is Spectral leakage? Give remedy to this problem.

(j) What are the main disadvantages of designing IIR filters using windowing technique?

Section-B

2. **Attempt any five questions from this section.** (10×5=50)

(a) Find the 10-point DFT of the following sequences:

i. $x(n) = \delta(n) + \delta(n-5)$

ii. $x(n) = u(n) - u(n-6)$

(b) Find circular convolution of the following sequences using concentric circle method.

$$x_1(n) = (1,2,2,1)$$

$$x_2(n) = (1,2,3,4)$$

(c) (i) Computer 4-point DFT of the following sequence using DIF algorithm

$$x(n) = \cos\frac{n\pi}{2}$$

(ii) Show that the same algorithm can be used to compute IDFT of $X(k)$ calculated in part (a).

(d) Compute the DFT of following 8-point sequence using 4-point Radix-2 DIT algorithm.

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

(e) Obtain Direct Form I, Direct Form II and Parallel Form structures for the following filter

$$y(h) = \frac{3}{4}y(h-1) + \frac{3}{32}y(h-2) + \frac{1}{64}y(h-3) + x(h) + 3x(h-1) + 2x(h-2)$$

(f) Consider the causal linear-shift-invariant filter with the system function

$$H(z)=\frac{1+0.875z^{-1}}{(1+0.2z^{-1}+0.9z^{-2})(1-0.7z^{-1})}$$

Obtain following realizations:

(a) Direct Form II

(b) A cascade of first-order and second-order system realized in transposed DF II

(c) A Parallel connection of first-order and second-order systems realized in DF II (2+4+4)

(g) A filter is to be designed with the following desired frequency response:

$$H_d(e^{jw})=\begin{cases} 0 & \frac{-\Pi}{4}\le w\le\frac{\Pi}{4} \\ e^{-j2w} & \frac{\Pi}{4}\le w\le\Pi \end{cases}$$

(h) Transform the prototype LPF with system function

$H_{LP}(s)=\dfrac{\Omega p}{s+\Omega p}$ into a

(i) HPF with cut-off frequency Ωp

(ii) BPF with upper and lower cut-off frequencies Ωu and Ωz respectively.

Section-C

Attempt any two questions from this section. (15×2 = 30)

3. (a) Prove that multiplication of the DFTs of two sequences is equivalent to the circular convolution of the two sequences in the time domain.

(b) If the 10-point DFT of $x(n)=\delta(n)-\delta(n-1)$ and $h(n)=u(n)-u(n-10)$ are $X(k)$ and $H(k)$ respectively, find the sequence $w(n)$ that corresponds to the 10-point inverse DFT of the product $H(k).X(k)$. (7+8)

4. (a) (i) Compute 4-point DFT of the following sequence using linear transformation matrix

$x(n)$ = (1, 1–2, –2)

(ii) Find IDFT $x(n)$ from $X(k)$ calculated in part(i). (2.5×2=05)

(b) Use Radix-2 DIT algorithm for efficient computation of 8-point DFT of $x(n) = 2^n$. (10)

5. (a) An FIR filter has following symmetry in the impulse response:

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

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

(b) Discuss the Bilinear Transformation method of converting analog IIR filter into digital IIR filter. What is Frequency Warping? (7+8)