

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

Paper ID : 131661

Roll No.

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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,

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

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. ($10 \times 5 = 50$)

- (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) Compute 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:

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

- (h) Transform the prototype LPF with system function

$$H_{LP}(s) = \frac{\Omega_p}{s + \Omega_p} \text{ into a}$$

(4)

- (i) HPF with cut-off frequency Ω_p
- (ii) BPF with upper and lower cut-off frequencies Ω_u and Ω_z 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:

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

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)