Code No: 126EK

**R13**

# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
## B. Tech III Year II Semester Examinations, May - 2017
## DIGITAL SIGNAL PROCESSING
### (Common to ECE, EIE)

Time: 3 hours                                                              Max. Marks: 75

Note:  This question paper contains two parts A and B.
       Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B
       consists of 5 Units. Answer any one full question from each unit. Each question carries
       10 marks and may have a, b, c as sub questions.

## PART - A
**(25 Marks)**

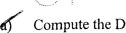| | | |
|---|---|---|
| 1.a) | What is an LTI system? | [2] |
| b) | Define the frequency response of a discrete-time system. | [3] |
| c) | Define discrete Fourier series. | [2] |
| d) | Obtain the circular convolution of the sequence x(n)={1,2,1}; h(n)={1,-2,2}. | [3] |
| e) | What is meant by bilinear transformation? | [2] |
| f) | Prove that physically realizable and stable IIR filters cannot have linear phase. | [3] |
| g) | What are the disadvantages of Fourier Series Method? | [2] |
| h) | What is the desirable characteristics of the Window? | [3] |
| i) | What is the need for anti-imaging filter after up sampling a signal? | [2] |
| j) | What are the effects of Dead band? | [3] |

## PART - B
**(50 Marks)**

2.a)  Determine whether each of the following systems defined below is (i) Causal (ii) Linear
      (iii) Dynamic  (iv) Time invariant (v) Stable.

$$\text{(I) } y(n) = \sum_{k=n-3}^{n} e^{x(k)} \quad \text{(II) } y(n) = x(-n-2)$$

b)  For each impulse response listed below, determine whether the corresponding system is
    (i) causal    (ii) stable.                                                      [5+5]
    (I) $h(n) = 2^n u(-n)$          (II) $h(n) = e^{2n} u(n-1)$

### OR

3.a)  If x(n) is a causal sequence, find the z- transform of the following sequences.
      (i) $x(n) = nu(n)$      (b) $x(n) = nu(n-1)$

b)  Find the response of $y(n) + y(n+1) - 2y(n-2) = u(n-1) + 2u(n-2)$   due to
    $y(-1) = 0.5; y(-2) = 0.25.$                                                    [5+5]

4.a)  Compute the DFT of the square-wave sequence

$$x(n) = \begin{cases} 1 & 0 \le n \le \dfrac{N}{2} - 1 \\ -1 & \dfrac{N}{2} \le n \le N-1 \end{cases} \quad \text{Where N is even.}$$

b)  Find 4-point DFT of the following sequence $x(n) = \left(\dfrac{1}{4}\right)^n$.                    [5+5]

5.a) An 8-point sequence is given by $x(n) = \{2,2,2,2,1,1,1,1\}$. Compute 8-point DFT of x(n) by radix-2 DIT-FFT.

b) Compute the DFT of the sequence $x(n) = \cos\dfrac{n\pi}{2}$, where N=4 using DIF FFT algorithm. [5+5]

6. Design a chebyshev filter for the following specifications using (a) bilinear transformation. (b) Impulse Invariance method. $z = e^{sT}$ [10]

$$0.8 \le \left|H\left(e^{jw}\right)\right| \le 1 \quad 0 \le w \le 0.2\pi$$
$$\left|H\left(e^{jw}\right)\right| \le 0.2 \quad 0.6\pi \le w \le \pi$$

7.a) Design a lowpass filter that will operate on the sampled analog data such that the cutoff frequency is 200Hz and at 400Hz, the attenuation is atleast 20dB with a monotonic shape past 200Hz. Take T = $\dfrac{1}{2000}$ secs and use normalized lowpass filter.

b) A third-order Butterworth low pass filter has the transfer function:

$H(s) = \dfrac{1}{(s+1)(s^2+s+1)}$. Design H(z) using Impulse Invariance method. [5+5]

8.a) Design an ideal Hilbert transformer having frequency response

$$H\left(e^{jw}\right) = \begin{cases} j & for & -\pi \le w \le 0 \\ -j & for & 0 \le w \le \pi \end{cases} \text{; using rectangular window.}$$

b) For the desired frequency response given by

$$H_d(w) = \begin{cases} e^{-j3w}, & |w| < \dfrac{3\pi}{4} \\ 0, & \dfrac{3\pi}{4} < |w| < \pi \end{cases}$$

Find H(ω) for N=7 using Hamming window for truncating $h_d(n)$. [5+5]

9.a) Design an FIR digital filter H(z) that when used in the prefilter A/D -H(z) – D/A structure will satisfy the following equivalent analog specifications.
i) Low pass filter with -1dB cutoff at 100π rad/sec.
ii) Stop band attenuation of 35dB or greater at 1000π rad/sec.
iii) Sampling rate of 2000 samples/sec.
iv) The phase must be linear.

b) Draw the magnitude response, $|W(\omega)|$ versus ω, for nine-term windows of the following
i) Rectangular window  ii) Hanning window. [6+4]

10.a) Explain the application of sampling rate conversion in subband coding.
b) Discuss in detail the down sampling with a neat diagram. [5+5]

11.a) Explain the multistage implementation of sampling rate conversion.
b) Explain the finite word length effects in digital filter. [5+5]

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