Code No: 126EK **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, April - 2018
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) Show that δ(n) = u(n) – u(n-1) [2]
b) Find the Z-transform $f(n) = n^2 u(n)$ [3]
c) State and prove the any three properties of DFT. [2]
d) What is the basic operation of DIF algorithm? [3]
e) What are the properties of Butterworth Low pass filter? [2]
f) Discuss the stability of the impulse invariant mapping technique [3]
g) Explain the effects of truncating an infinite Fourier series into a finite series. [2]
h) What is the condition for the impulse response of FIR filter to satisfy for constant group and phase delay and for constant group delay? [3]
i) What is the need for Multirate Digital Signal Processing [2]
j) What do you mean by quantization step size? [3]

PART-B

(50 Marks)

2.a) An LTI system is characterized by an impulse response

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

Find the step response of the system. Also, evaluate the output of the system at n=±5.
b) Consider a discrete-time system characterized by the following input-output relationship $y(n) = x(n-2) - 2x(n-17)$. Determine whether the system is memory less, time-Invariant, linear, causal and stable. [5+5]

OR

3.a) Given the difference equation $y(n) + b^2 y(n-2) = 0$ for $n \geq 0$ and $|b| < 1$. With initial conditions $yf(-1) = 0$ and $y(-2) = -1$, Show that

$$y(n) = b^{n+2} \cos\left(\frac{n\pi}{2}\right)$$

b) Find the Z-transform of the sequence f(n) defined below: [5+5]

$$f(n) = \begin{cases} 3^n & n < 0 \\ \left(\frac{1}{3}\right)^n & n = 0, 2, 4..... \\ \left(\frac{1}{2}\right)^n & n = 1, 3, 5..... \end{cases}$$

4.a) Find the IDFT of the sequence X(K) given below

X(K) = {1,0,0, j, 0, -j, 0,0}

b) Obtain the 10 point DFT of the sequence $x(n) = \delta(n) + 2\delta(n-5)$. [5+5]

OR

5.a) Find the IDFT of the sequence X(K) = {20, -5.828-j2.414,0,-0.712-j0.414,0,-0.172+j0.414,0,-5.828+j2.414} using DIT- FFT algorithm.

b) Using FFT and IFFT, determine the output of system if input x(n)={2,2,4} and impulse response h(n) = {1,1}. [5+5]

6.a) Design a digital low pass filter using Chebyshev filter that meets the following Specifications: Passband magnitude characteristics that is constant to within 1dB for recurrences below ω = 0.2π and stopband attenuation of atleast 15dB for frequencies between ω = 0.3π and π. Use bilinear transformation.

b) An analog filter has the following system function. Convert this filter into a digital filter by using the impulse invariant technique: [5+5]

$$H(s) = \frac{1}{(s+0.1)^2 + 9}$$

OR

7.a) Using a bilinear transformation, design a Butterworth filter which satisfies the following conditions:

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

b) Determine H(z) using impulse invariance method for the following system function: [5+5]

$$H_a(s) = \frac{1}{(s+0.5)(s^2+0.5s+2)}$$

8.a) The desired frequency response of a low pass filter is given

$$H_d\left(e^{j\omega}\right) = \begin{cases} e^{-j\omega} & \frac{-3\pi}{4} \le \omega \le \frac{3\pi}{4} \\ 0 & \frac{3\pi}{4} \le |\omega| \le \pi \end{cases}$$

Find H($e^{j\omega}$) for M=7 using a rectangular window

b) Explain the type II frequency sampling method of designing an FIR digital filter. [5+5]

OR

9.a) Design a band pass filter which approximates the ideal filter with cutoff-frequencies at 0.2rad/sec and 0.3rad/sec. The filter order is M=7. Use the Hanning window function

b) Design an ideal band pass filter with a frequency response. [5+5]

$$H_d\left(e^{j\omega}\right) = \begin{cases} 1 & for\ \frac{\pi}{4} \le |\omega| \le \frac{3\pi}{4} \\ 0 & otherwise \end{cases}$$

10.a) Explain the interpolation process for an integer factor I with an example

b) Given the limit cycle behavior $y(n) = 0.7y(n-2) + 0.52y(n-1) + x(n)$. Find the dead band of the above two systems. [5+5]

OR

11.a) The signal $x(n)$ is defined by

$$g(n) = \begin{cases} A^n & n > 0 \\ 0 & otherwise \end{cases}$$

i) Obtain the decimated signal with a factor of 3

ii) Obtain the interpolated signal with a factor of 3

b) Given the system $y(n) = \frac{1}{2}y(n-1) + x(n)$

i) Calculate the response to the input $x(n) = \left(\frac{1}{4}\right)^n u(n)$ assuming infinite precision arithmetic.

ii)Calculate the response $y(n), 0 \leq n \leq 5$ to the same input assuming finite precision with five bits, one sign bit plus four fractional bits. The quantization is performed by truncation. Discuss the results. [5+5]

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