R13

Code No: 126EK

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, May - 2019

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) Find the power and the energy of the unit step sequence. [2]
b) Express the Z transform of $y(n) = \sum_{k=-\infty}^{n} x(k)$ in terms of X(Z). [3]
c) Explain about the direct computation of DFT. [2]
d) What are the differences and similarities between DIF and DIT algorithm? [3]
e) List out the properties of Chebyshev filter. [2]
f) What is an IIR digital filter? Compare an IIR filter with an FIR filter. [3]
g) What are the desirable features of window functions? [2]
h) Compare the frequency domain characteristics of different window functions. [3]
i) What do you mean by decimation? [2]
j) Give the steps in multistage sampling rate converter design. [3]

PART-B

(50 Marks)

2.a) Given a periodic sequence F(n) = {1, 1, 1, -1, -1, -1, 1, 1, 1, -1}. Show that

$$F(Z) = \frac{Z(z^2 + z + 1)}{z^3 + 1}$$

b) A system is represented by the difference equation
$y(n) = 3y^2(n-1) - nx(n) + 4x(n-1) - 2x(n+1), n \geq 0.$
Find whether the system is linear, time-invariant or causal. [5+5]

OR

3.a) Draw parallel structure realization for the following system

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

b) Find $f(n)$ corresponding to the difference equation
$f(n-2) - 2f(n-1) + f(n) = 1 \; for \; n \geq 0$ with initial condition
$f(-1) = -0.5$ and $f(-2) = 0$. Show that $f(n) = (0.5)n^2 + n$ for $n \geq 0$. [5+5]

4.a) Find the N-point DFT of $x(n) = b^n \cos an$ using the linearity property

b) Given DFT{x(n)}= X(k) = { 1,1-j,1,0,1,0,1,1+j}, 0≤ k, n≤7. Using the property of DFT, determine the DFT of the sequence $x_1(n) = x(n)e^{j\frac{2\pi n}{8}}$. [5+5]

OR

5.a) Find 8-point DFT X(K) of the real sequence
$x(n) = \{0.707,1,0.707,0,-0.707,-1,-0.707,0\}$ by using DIF radix-2 FFT.

b) Find the 8-point DFT of the sequence
$x(n) = \{1,2,3,4,4,3,2,1\}$ using DIT-FFT radix 2 algorithm. [5+5]

6.a) The system function of an analog filter is expressed as

$$H(s) = \frac{(s+0.2)}{(s+2)^2+9}$$

Convert this analog filter into a digital filter by making use of the impulse invariant techniques. Assume T=1sec.

b) A digital low pass IIR filter is to be designed with Butterworth approximation using bilinear transformation technique. Find the order of the filter to meet the following specifications
i) Passband magnitude is constant within 1 dB for frequencies below 0.2π
ii) Stopband attenuation is greater than 15dB for frequencies between 0.3π to π. [5+5]

OR

7.a) The system transfer function of analog filter is given by

$$H_a(s) = \frac{s+0.2}{(s+0.1)^2+16}$$

Obtain the system transfer function of digital filter using bilinear transformation
Which is resonant at $\omega_r = \frac{\pi}{2}$

b) Design a low pass 1 rad/sec bandwidth Chebyshev filter with following characteristics
i) Acceptable passband ripple of 2dB
ii) Cut-off radian frequency of 1 rad/sec
iii)Stop band attenuation of 20dB or greater beyond 1.3 rad/sec. [5+5]

8.a) Design an ideal band reject filter with a desired frequency response

$$H_d(e^{j\omega}) = \begin{cases} 1 & for\ |\omega| \le \frac{\pi}{3}\ and\ |\omega| \ge \frac{2\pi}{3} \\ 0 & otherwise \end{cases}$$

Determine the value for N=11. Find H(z) and plot the magnitude response.

b) Derive an expression for system function if the unit sample response h(n) is obtained using frequency sampling technique. [5+5]

OR

9.a) Design a low pass filter FIR filter using frequency sampling technique having cutoff frequency of $\frac{\pi}{2}$ rad/sample. The filter should have linear phase 4 and length 17.

b) Design a normalized linear phase FIR filter having the phase delay of $\tau = 4$ and atleast 40dB attenuation in the stop band. Also, obtain the magnitude/frequency response of the Filter. [5+5]

10.a) Find the single stage, two stage, three-stage and multistage realization of the decimator With the following specifications. Sampling rate of a signal has to be reduced from 10kHz to 500Hz. The decimation filter H(z) has the passband edge (F_p) to be 150Hz, stopband edge (F_s) to be 180Hz.

Passband ripple δ_p=0.002

Stopband ripple δ_s=0.001

b) Explain the characteristics of a limit cycle oscillations with respect to the system described by the difference equation

$$y(n) = 0.95\, y(n-1) + x(n)$$

Determine the dead band filter. [5+5]

OR

11.a) Implement a two-stage decimator for the following specifications:

Sampling rate of the Input signal $x(n)$

$$F_s = 20{,}000Hz$$

Decimation Factor, D = 100

Pass band = 0 to 50 Hz

Transition ripple = 0.01

Stop band ripple = 0.002

b) The output of the 12 bit A/D converter is passed through a digital filter which is described by the difference equation $y(n) = x(n) + 0.2y(n-1)$. Compute the steady state output noise power due to A/D converter quantization. [5+5]

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