Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree 7th semester (S,FE) Exam April 2025 (2019 Scheme)

Course Code: EET453

Course Name: DIGITAL SIGNAL PROCESSING

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all questions, each carries 3 marks. Marks

1 Find the 2-point DFT of $x(n)=\{1,2\}$ (3)

2 Compare the number of complex additions and multiplications for DFT with i) direct computation and ii) using FFT. (3)

3 Write the expressions for system function H(z) of IIR and FIR systems. (3)

4 Draw the single-stage lattice structure of FIR system showing the input and output. (3)

5 Find H(z) using impulse invariant transformation. $H(s)=\frac{2}{(s+1)}$. Take T = 1 (3)

6 Find the order of a Chebyshev analog lowpass filter with a maximum passband attenuation of 2.5dB at Ω_p = 20 rad/sec and the stopband attenuation of 30dB at Ω_s = 50 rad/sec. (3)

7 Represent +9.25 in IEEE 754 single-precision floating point format (3)

8 Explain the need of window functions for the design of FIR filters. (3)

9 List the finite word length effects in digital filters. (3)

10 Differentiate between rounding and truncation. (3)

PART B

Answer any one full question from each module, each carries 14 marks.

Module I

11 Compute 8-point DFT of the sequence $x(n)=\{1,1,3,3,1,1,2,2\}$ using DIT FFT. (14)

OR

12 Two finite duration sequences are $h(n)=\{1,0,1\}$ and $x(n)=\{-1,2,-1,0,1,3,-2,1,-3,-2,-1,0,-2\}$. Use i) overlap-save method and ii) overlap-add method to find $y(n)=x(n)*h(n)$. Also check your result by performing the linear convolution. (14)

Module II

13 a) Find the direct form II realization of the IIR system (5)

$$H(z)=\frac{8-4z^{-1}+11z^{-2}-2z^{-3}}{1-\frac{5}{4}z^{-1}+\frac{3}{4}z^{-2}-\frac{1}{8}z^{-3}}$$

b) A linear-time invariant system is defined by (9)

$H(z)=\frac{-0.2+0.18z^{-1}+0.4z^{-2}+z^{-3}}{1+0.4z^{-1}+0.18z^{-2}-0.2z^{-3}}$. Obtain the lattice-ladder structure.

OR

14 Realize the system function using i) direct form 1 ii) direct form 2 iii) cascade realization and iv) parallel realization. $H(z)=\frac{0.52}{(1+0.9z^{-1})}+\frac{0.18}{(1-0.8z^{-1})}$. (14)

Module III

15 a) Derive the expression for H(z) using impulse invariant transformation if (6)

$$H(s)=\frac{s+a}{(s+a)^2+b^2}.$$

b) For the given specifications, design an analog Butterworth low pass filter. (8)

$0.9 \le |H(j\Omega)| \le 1$ for $0 \le \Omega \le 0.2\pi$

$|H(j\Omega)| \le 0.2$ for $0.2\pi \le \Omega \le \pi$

OR

16 Design a digital Chebyshev filter to satisfy the constraints (14)

$0.707 \le |H(j\Omega)| \le 1$ for $0 \le \Omega \le 0.2\pi$

$|H(j\Omega)| \le 0.1$ for $0.5\pi \le \Omega \le \pi$

Using bilinear transformation and assuming T = 1 sec.

Module IV

17 A lowpass filter is to be designed with the following desired frequency (14)

response $H_d(e^{j\omega})=\begin{cases} e^{-j3\omega} & |\omega| \le \frac{3\pi}{4} \\ 0 & \frac{3\pi}{4} \le |\omega| \le \pi \end{cases}$

Determine the filter coefficients $h_d(n)$ and h(n) if w(n) is a Hamming window with N=7.

Also, determine the frequency response $H(e^{j\omega})$ of the resulting FIR filter.

OR

18 a) A low pass filter is to be designed with the following desired frequency response $H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega} & 0 \le \omega \le \frac{\pi}{2} \\ 0 & \frac{\pi}{2} \le \omega \le \pi \end{cases}$ (9)

Determine the filter coefficients with N = 7 using frequency sampling method.

b) What is a linear phase filter? What conditions are to be satisfied by the impulse response of an FIR system in order to have a linear phase? (5)

Module V

19 a) Explain coefficient quantisation in IIR filters. (7)

b) What is meant by limit cycles in recursive filters? (7)

OR

20 a) A digital system is characterised by the difference equation, $y(n) = 0.95y(n-1) + x(n)$. Determine the deadband of the system when x(n) = 0 and y(-1) = 13. (7)

b) Using a block diagram, explain the Harward architecture of a digital signal processor. (7)

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