Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (S,FE) (FT) (WP/PT) Examination May 2025 (2019 Scheme)

Course Code: ECT303
Course Name: DIGITAL SIGNAL PROCESSING

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

1	The impulse response of a discrete time LTI system is h(n)= {1 2 1}. Determine the output of the system using circular convolution if the input is x(n)={2, 1, -1, 4}.	3
2	Define circularly odd and even sequences with an example for each.	3
3	Write the steps involved in the efficient computation of the DFT of two real sequences.	3
4	Draw the basic butterfly computation diagrams involved in radix-2 DIT and DIF FFT algorithms.	3
5	Derive the expression for the impulse response of an ideal linear phase FIR highpass filter from its frequency response.	3
6	What is frequency warping in bilinear transformation? How can it be eliminated?	3
7	What is a signal flow graph? Give an example. Define transposition theorem.	3
8	Draw the direct form structure of $H(z) = 1 + z^{-1} + 1.5z^{-2} + 3.2z^{-3}$.	3
9	What are the key features of Harvard architecture?	3
10	How does a 2's complement fraction represent in fixed point arithmetic? Write 2's complement representation of -5/8 and 5/8.	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11	a)	The first five points of 8-point DFT of a real sequence are {0.3, 0.1-j0.2, 0, 0.4+j0.8, 0}.	7
		i) Determine the remaining 3 points without computing the DFT	
		ii) State and prove the property of DFT employed in i).	

b) Verify circular convolution property of DFT for $x(n) = \{1,1,0,0\}$, $h(n) = \left\{\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}\right\}$ 7

12 a) Determine the circular convolution of $x(n) = \{1,2,4,2\}, h(n) = \{3,4,1,0\}$. 5

b) Determine the output y(n) of a filter whose impulse response is h(n)={1,2,1} for the input x(n)={4,-1,0,2,1,-2,5,1,1,3,4,6,5,1} using overlap save method. 9

Module -2

13 a) Compute the 8-point DFT of the sequence x(n)={ 1, 1, -1, -1, -1, 1, 1, 1} using radix-2 Decimation in Time FFT algorithm. 7

b) Find the 4-point DFT of $x_1(n)$={1,4,3,2} and $x_2(n)$={1,-1,3,3} using a single 4-point DFT computation. 7

14 a) Determine the 8-point DFT of g(n)={1,2,3,4,4,3,2,1} using one 4-point DFT. 7

b) Find the IDFT of X(k)={12,0,-2-j2,0,0,0,-2+j2,0} using radix-2 Decimation in Frequency algorithm. 7

Module -3

15 a) Design a linear phase FIR lowpass filter having filter order N=7 and cutoff frequency $w_c = \pi/4$ using Hann window. 9

b) Derive the expression for the frequency response of symmetric linear phase FIR filter with filter N, an odd number. 5

16 a) Design a digital IIR Butterworth lowpass filter with passband edge frequency $w_p = \pi/4$, stopband edge frequency $w_s = \pi/2$. The minimum passband gain = -3 dB, minimum stopband attenuation = 10dB. Use bilinear transformation (T=1sec). 9

b) Design a digital filter equivalent to analog filter $H(s) = \frac{6s}{3s^2+7s+4}$ using impulse invariant method (T=1 sec). 5

Module -4

17 a) Obtain the direct form and cascade structures (one first order and one second order) of the given FIR filter having transfer function $H(z) = 1 + 2Z^{-1} + Z^{-2} + \frac{1}{8}Z^{-3}$ 7

b) i) Let x(n)=u(n)-2u(n-5)+u(n-10) and y(n)=x(3n). Plot the sequences x(n) and y(n). 7

ii) Is it possible to interchange the upsampling and down sampling operations in multirate signal processing. Substantiate your answer with proper justification.

18 a) Obtain the direct form I, direct form II and parallel structures (3 first order subsystems) of the given IIR filter having transfer function 9

$$H(Z) = \frac{1 + 3Z^{-1} + \frac{1}{8}Z^{-2}}{1 - \frac{7}{12}Z^{-1} - \frac{11}{24}Z^{-2} + \frac{1}{4}Z^{-3}}$$

b) Draw the frequency spectrum of y(n), where y(n)=x(n/2). The frequency spectrum of x(n) is given in Figure 1. 5

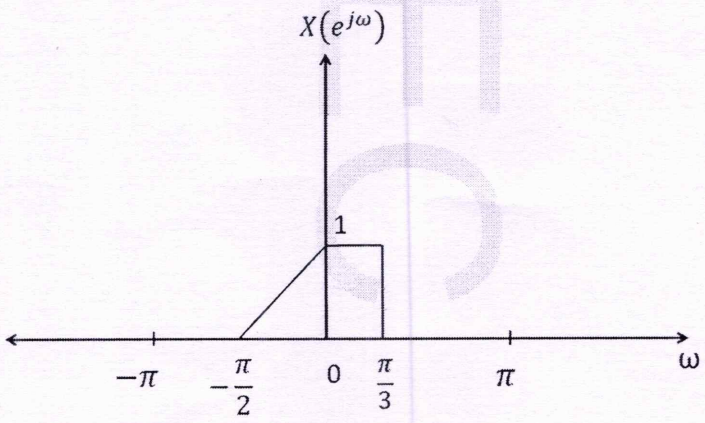

Figure 1

Module -5

19 a) Explain the functional units of TMS320C67xx digital signal processor with a neat block diagram. 10

b) Illustrate the concept of pipelining in digital signal processors. 4

20 a) Explain the effect of roundoff errors in FFT algorithms. 7

b) Define IEEE floating-point number representation. Illustrate floating point addition and multiplication operations. 7

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