ENTRI

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Examination December 2023 (2019 Scheme)

Course Code: ECT 303

Course Name: DIGITAL SIGNAL PROCESSING

Max. Marks: 100 | Duration: 3 Hours (p. 1)

PART A

(Answer all questions; each question carries 3 marks) **(p. 1)**

1. **State and prove Parseval's theorem. (p. 1)**
2. **Obtain linear convolution of the sequences** $x(n) = \{1, 2, 3\}$ & $h(n) = \{-1, -2\}$ **using circular convolution. (p. 1)**
3. **Find the number of complex multiplications involved in the calculation of a 64-point DFT using (i) direct computation (ii) radix-2 FFT algorithm. (p. 1)**
4. **What is twiddle factor? (p. 1)**
5. **Derive the mapping between s and z in bilinear transformation. (p. 1)**
6. **Given the specification pass band attenuation is 1 dB, stop band attenuation is 30 dB, pass band edge frequency 200 rad/sec and stop band edge frequency 600 rad/sec. Determine the order of the Butterworth Analog filter? (p. 1)**
7. **Draw the direct form realization of FIR system. (p. 1)**
8. **Why antialiasing filter is used in decimating systems? (p. 1)**
9. **What are the different stages in pipelining? (p. 1)**
10. **Compare Von Neumann and Harvard architecture. (p. 1)**

PART B

(Answer one full question from each module, each question carries 14 marks) **(p. 1)**

Module - 1

11. a) Consider the length -12 sequence defined for $0 \leq n \leq 12$ **is** $x(n) = \{3, -1, 2, 4, -3, -2, 0, 1, -4, 6, 2, 5\}$ **with a 12-point DFT. Evaluate the following functions of $X(k)$ without computing DFT: (p. 1)**

a. X(0)

b. X(6)

c. $\sum_{k=0}^{11} X(k)$

d. $\sum_{k=0}^{11} |X(k)|^2$ **(p. 2)**

b) State and prove time shifting property of DFT. (6 marks) (p. 2)

OR

12. a) Find the convolution of x(n) = {1, 2, 3, 4, 5, 6, 7, 8, 9} and h(n) = {2, 4, 6} using overlap add method. (7 marks) (p. 2)

b) Find the 4-DFT of the sequence {1, 1, 1, 0} and plot |X(K)|. (7 marks) (p. 2)

Module - 2

13. a) Given $x(n) = (n+1)$ for $0 \leq n \leq 7.$ **Find X(k) using DIT-FFT algorithm. (8 marks) (p. 2)**

b) Compare DIT and DIF algorithms. (6 marks) (p. 2)

OR

14. a) Explain how a 2N point DFT of a 2N point real-valued sequence can be found by computing a single N point DFT. (6 marks) (p. 2)

b) Find the IDFT of the sequence

$X(k) = \{4, 1 - j2.414, 0, 1 - j0.414, 0, 1 + j0.414, 0, 1 + j2.414\}$ **using DIF-FFT algorithm. (8 marks) (p. 2)**

Module - 3

15. a) Design a Butterworth filter using bilinear transformation. Specifications of desired LPF are:

$0.9 \le |H(w)| \le 1; 0 \le w \le \pi/2$ and $|H(w)| \le 0.2, 3\pi/4 \le w \le \pi. T = 1$ sec,

$A_p = 0.9, A_s = 0.2, w_p = \pi/2, w_s = 3\pi/4.$ **(8 marks) (p. 2)**

b) Derive equations for magnitude and phase responses of FIR filter whose impulse response is symmetric and length N even. (6 marks) (p. 2)

OR

16. a) The desired frequency response of LPF is

$H_d(w) = e^{-j3w}, |w| \le 3\pi/4$ **and 0 otherwise. Determine the frequency response of FIR filter if Hamming window is used. (N=7) (10 marks) (p. 2)**

b) Convert the analog filter H(s) given below into a second order Butterworth digital filter using impulse invariance technique.

$$H(s) = \frac{1}{s^2 + \sqrt{2}\, s + 1}.$$

(4 marks) (p. 2)

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Module - 4

17. a) When is a cascade form realization preferred in FIR filters? Obtain cascade realization with minimum number of multipliers for the system function

$$H(z) = (\frac{1}{2} + z^{-1} + \frac{1}{2} z^{-2})(1 + \frac{1}{3} z^{-1} + z^{-2}).$$ **(7 marks) (p. 2) (p. 3)**

b) How upsampling and downsampling affect the frequency spectrum of a signal x(n) with frequency spectrum $X(e^{j\omega})$**? Explain the need of low pass filter prior to downsampling. (7 marks) (p. 3)**

OR

18. a) What are multirate DSP systems? Give the output of decimation by M system in time domain. (4 marks) (p. 3)

b) Obtain the cascade and parallel form realization for the system

$$y(n) = -0.1y(n-1)$$

$$+ 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n-2).$$ **(10 marks) (p. 3)**

Module - 5

19. a) Explain the effects of coefficient quantization in IIR and FIR filters. (7 marks) (p. 3)

b) What are the main features of a DSP processor? Give the significance of MAC unit in a DSP processor. (7 marks) (p. 3)

OR

20. a) Draw the block diagram of TMS320C67XX and briefly explain the function of each block. (10 marks) (p. 3)

b) Write a short note on finite word length effects in DSP systems. (4 marks) (p. 3)