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Fifth Semester B.E. Degree Examination, Jan./Feb. 2021

Digital Signal Processing

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Show that the multiplication of two DFT's leads to circular convolution of the corresponding time sequences. (08 Marks)
- b. Compute the N – point OFT's of the signals :
 - i) $x(n) = \begin{cases} 1, & 0 \leq n \leq \frac{N}{2} - 1 \\ 0, & \frac{N}{2} \leq n \leq N - 1 \end{cases}$
 - ii) $x(n) = \cos \frac{2\pi}{N} k_0 n, 0 \leq n \leq N-1.$ (07 Marks)
- c. Given $x(n) = \{1, 2, 3, 4\}$, find $y(n)$, if $y(k) = x((k-2))_4.$ (05 Marks)

OR

- 2 a. State and prove the Circular time shift property of DFT. (06 Marks)
- b. Determine the circular convolution of $x_1(n) = \{1, 2, 3, -1\}$ and $x_2(n) = \{4, 3, 2, -2\}$, using Time domain formula. Verify the result using Frequency domain approach. (09 Marks)
- c. For the sequence $x(n) = \{-1, 2, 3, 0, -4, 1, 2, -3\}$, Calculate
 - i) $\sum_{k=0}^7 x(k)$ and
 - ii) $\sum_{k=0}^7 |x(k)|^2$, without computing the DFT. (05 Marks)

Module-2

- 3 a. Write the computational procedure to find the filtered output using Overlap Add method. (07 Marks)
 - b. Find the 8 – point DFT of the sequence $x(n) = \{-1, 0, 2, 3, -4, -2, 0, 5\}$, using radix – 2 DIT – FFT algorithm. (09 Marks)
 - c. Compare the complex additions and complex multiplications for the direct computation of DFT versus the FFT algorithm for $N = 128.$ (04 Marks)
- OR**
- 4 a. Derive the radix – 2 DIF – FFT algorithm and draw the signal flow graph for $N = 8.$ Comment on the number of computations required to find N – point DFT. (07 Marks)
 - b. Using Overlap save method, find the output of a filter whose impulse response $h(n) = \{1, -2, 3\}$ and input $x(n) = \{2, 3, -1, 0, 5, 2, -3, 1\}.$ Use 6 – point circular convolution. (09 Marks)
 - c. Given $X(k) = \{1, j4, 1, -j4\}$, find $x(n)$ using radix – 2 DIT – FFT algorithm. (04 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.



Module-3

- 5 a. Design an FIR filter for the following desired frequency response

$$H_d(w) = \begin{cases} e^{-j3w}, & \text{if } |w| \leq \frac{\pi}{4} \\ 0, & \text{if } |w| > \frac{\pi}{4} \end{cases}$$

Use the Hamming window function, obtain the frequency response of the designed FIR filter. (10 Marks)

- b. For the System function $H(z) = 1 + 2.8z^{-1} + 3.4z^{-2} + 1.7z^{-3} + 0.4z^{-4}$. Obtain the Lattice coefficients and sketch the Lattice structure. (10 Marks)

OR

- 6 a. Find the Impulse response of an FIR filter with the following desired frequency response,

$$H_d(w) = \begin{cases} 0 & ; \text{ if } |w| \leq \frac{\pi}{6} \\ e^{-j4w} & ; \text{ if } |w| > \frac{\pi}{6} \end{cases}$$

Use Rectangular window function. Draw the direct form structure for the designed filter. (10 Marks)

- b. Consider an FIR Lattice filter coefficients $K_1 = 0.65$, $K_2 = 0.5$, $K_3 = 0.9$. Find its impulse response and draw the direct form structure. (10 Marks)

Module-4

- 7 a. Define the First order analog low pass filter prototype. How this prototype is transformed into a different filter types. (05 Marks)

- b. Design a Second order digital low pass Butterworth filter with a cutoff frequency of 3.4 kHz at a sampling frequency of 8000Hz. Draw the direct Form – II structure of this filter. Use Bilinear transformation. (10 Marks)

- c. Discuss the general mapping properties of bilinear transformation and show the mapping between the S – plane and the the Z – plane. (05 Marks)

OR

- 8 a. Define the Normalized low pass prototype function of Butterworth filter and derive the expression for the filter order. (05 Marks)

- b. Using Bilinear transformation, design a digital low pass Butterworth filter with the following specifications : Sampling frequency : 8000Hz , 3 dB attenuation at 1.5 kHz. 10 dB stop band attenuation at 3kHz. (10 Marks)

- c. Realize the following digital filter using direct Form – II

$$H(z) = \frac{0.7 + 1.4z^{-1} + 0.7z^{-2} + 0.5z^{-3}}{1 + 1.3z^{-1} + 0.5z^{-2} + 0.7z^{-3} + 0.3z^{-4}} \quad (05 \text{ Marks})$$

Module-5

- 9 a. With a neat diagram, explain the Harvard architecture used in DS processors. (06 Marks)

- b. Illustrate the operation of circular buffers used for address generation in DS processors. (07 Marks)

- c. Convert the following decimal numbers into the floating point representation

i) 0.640492×2^{-2} ii) -0.638454×2^5 .

Use 4 – bits to represent exponent and 12 – bits for mantissa. (07 Marks)

OR

- 10 a. With a neat diagram, explain the basic architecture of TMS320C54X family DS processors. (10 Marks)

- b. Describe the IEEE single precision floating point format used in DS processors. (05 Marks)

- c. Find the signed Q – 15 representation for the decimal number 0.560123. (05 Marks)