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18EC52

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.***

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-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) $x(n) = \begin{cases} 1, & 0 \le n \le N/2 - 1 \\ 0, & \frac{N}{2} \le n \le N-1 \end{cases}$.

ii) $x(n) = \cos \frac{2\pi}{N} k_0 n$, $0 \le n \le N-1$. **(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 $x_1(n) = \{\underset{\uparrow}{1}, 2, 3, -1\}$ 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)**

Module-3

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

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

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,

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

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 fitler 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

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