21EC42

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Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Prove that the sampling of Fourier transform of a sequence x(n) results in N – point DFT using which both the sequence and the transform can be reconstructed. **(10 Marks)**

  b. Compute the N – point DFT of $x(n) = a^n$ for $0 \leq n \leq N - 1$. And also find the DFT of the sequence $x(n) = 0.5n\ u(n)$; $0 \leq n \leq 3$. **(10 Marks)**

OR

2 a. Compute the circular convolution of the sequences and compare the results with linear convolution. (Use time domain approach).
  $x(n) = \{1, 1, 1, 1, -1, -1, -1, -1\}$; $h(n) = \{0, 1, 2, 3, 4, 3, 2, 1\}$. **(10 Marks)**

  b. If $x(n(= \{1, 2, 0, 3, -2, 4, 7, 5\}$, Evaluate the following :

  i) $x(0)$ ii) $x(4)$ iii) $\sum_{k=0}^{7} x(k)$ iv) $\sum_{k=0}^{7} |x(k)|^2$.

  Show that x(0) is always real. **(10 Marks)**

Module-2

3 a. State and prove the Periodicity property and Symmetry property of twiddle factor. **(05 Marks)**

  b. Given $x(n) = \{1, 2, 3, 4\}$ and $h(n) = \{1, 2, 2\}$. Compute Linear convolution using circular convolution. **(05 Marks)**

  c. Develop an 8 – point DIT – FFT algorithm. Draw the signal flow graph. Determine the DFT of the sequence, $x(n) = \{1, 1, 1, 1, 0, 0, 0, 0\}$. Using the signal flow graph, show all the intermediate results on the signal flow graph. **(10 Marks)**

OR

4 a. Find the response of LTI system with an impulse response $h(n) = \{3, 2, 1\}$ for the input $x(n) = \{2, +1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1\}$. Using overlap add method use 8 – point circular convolution. **(10 Marks)**

  b. What do you mean by computational complexity? Compare the direct computation and FFT algorithm. In the direct computation of 256 – point DFT of x(n). How many
  i) Complex multiplications   ii) Complex additions   iii) Real multiplications
  iv) Real additions and   v) Trigonometric function evaluations are required. **(10 Marks)**

Module-3

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

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

  Use the Hanning window function. Obtain the frequency response of the designed FIR filter. **(10 Marks)**

b. A FIR filter is given by $y(n) = x(n) + \frac{2}{5} x(n-1) + \frac{3}{4} x(n-2) + \frac{1}{3} x(n-3)$.

Draw the lattice structure and direct form. (10 Marks)

OR

6 a. Design a low pass digital filter to be used in an A/D – H(2) -- D/A structure that will have a -3 dB cutoff at 30 π rad/sec and an attenuation of 50dB at 45 π rad/sec. The filter is required to have a linear phase and the system will use a sampling rate of 100 samples 1 second. (10 Marks)

b. Given $H(z) = (1 + 0.6z^{-1})^5$. i) Realize in direct form   ii) Realize as a cascade of first order sections only   iii) As a cascade of 1st and 2nd order sections. (10 Marks)

Module-4

7 a. Derive an expression for order and cut off frequency of the Butterworth filter. (10 Marks)

b. Realize the following difference equation using digital structures :
   i) Direct form – I   ii) Direct form – II

   $y(n) - \frac{3}{4} y(n-1) + \frac{1}{8} y(n-2) = x(n) + \frac{1}{3} x(n-1)$. (10 Marks)

OR

8 a. The system function of the analog filter is given as $H_a(S) = \dfrac{S + 0.1}{(S + 0.1)^2 + 16}$. Obtain the system

   function of the digital filter using bilinear transformation which is resonant at $w_r = \frac{\pi}{2}$. (10 Marks)

b. Realize the following system functions

   $H(z) = \dfrac{8z^3 - 4z^2 + 11z - 2}{(z - 0.25)(z^2 - 2 + 0.5)}$. Using direct form – II. (05 Marks)

c. List the characteristics of commonly using Analog filters. (05 Marks)

Module-5

9 a. Explain the digital signal processors based on Harvard architecture. (10 Marks)

b. Discuss briefly the following special digital signal processor hardware units :
   i) Multiplier and Accumulator (μAC0 unit   ii) Shifters   iii) Address Generators. (10 Marks)

OR

10 a. Explain Fixed – Point digital signal process using basic architecture of TMS320C54X family. (10 Marks)

b. Illustrate the operation of circular buffers used for address generation in DS processors. (10 Marks)

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