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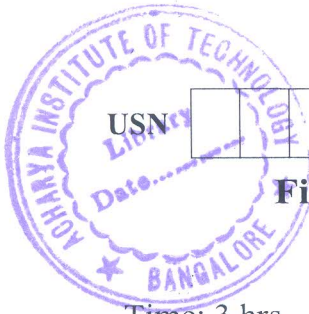**17EC52**

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
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 uniform sampling of Discrete – Time Fourier Transform of a sequence, $x(n)$ results in N – point DFT.   **(07 Marks)**

  b.   Evaluate the N – point DFT of a sequence $x(n) = 1 + \cos^2\left(\dfrac{2\pi n}{N}\right)$; $0 \le n \le N-1$. **(07 Marks)**

  c.   Derive the relationship of N – point DFT with Z - transform.   **(06 Marks)**

OR

2   a.   Define the DFT and IDFT of a sequence. Show that N – point DFT and IDFT are periodic with period 'N'.   **(07 Marks)**

  b.   Let $x(n)$ be a finite length sequence with its DFT $x(k) = \{1, 4j, 0, -4j\}$. Find the DFTs of

   i) $x_1(n) = e^{\frac{j\pi n}{2}} \cdot x(n)$ ii) $x_2(n) = \cos\left(\dfrac{\pi n}{2}\right).x(n)$ iii) $x_3(n) = x((n-\ell))_4$.

   Keep answer in terms of $x(k)$.   **(07 Marks)**

  c.   Compute the IDFT of a sequence $x(k) = \{24 , -2j , 0 , 2j\}$.   **(06 Marks)**

Module-2

3   a.   State and prove i) Circular time shift property   ii) Circular convolution property of DFTs. **(08 Marks)**

  b.   Define Twiddle factor. Prove the following properties of Twiddle factor :
   i)   Periodicity property   ii)   Symmetry property.   **(04 Marks)**

  c.   Find the output $y(n)$ of a filter whose impulse response $h(n) = \{1, 2, 3, 4\}$ for an input $x(n)$
   $x(n) = \{1, 2, 1, -1, 3, 0, 5, 6, 2, -2, -5, -6, 7, 1, 2, 0, 1\}$. Using overlap – add method.
   Use 6 – point circular convolution.   **(08 Marks)**

OR

4   a.   In direct computation of N – point DFT, how many i) Complex additions   ii) Complex multiplications   iii)   Trigonometric functions are required to calculate. Also explain the need of FFT algorithms.   **(06 Marks)**

  b.   Given $x_1(n) = \{1, 2, 3, 4\}$ and $x_2(n) = \{1, 2, 2\}$. Compute circular convolution $x_3(n)$ of $x_1(n)$ with $x_2(n)$ using Concentric Circle method.   **(07 Marks)**

  c.   Compute convolution of $x(n) = \{\underset{\uparrow}{1}, 2, 3\}$ with $h(n) = \{\underset{\uparrow}{4}, 5\}$ using DFT and IDFT method.

                                                                                       (07 Marks)

Module-3

5   a.   Find 8 – point DFT of a sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using Radix – 2 DIT – FFT algorithm.   **(10 Marks)**

  b.   What is Geortzel Algorithm? Obtain Direct form – II structure for the Geortzel filter.
                                                                                       (10 Marks)

OR

6 a. Develop Radix – 2 DIF FFT algorithm and draw complete signal flow graph for N = 8.
   (10 Marks)

   b. Compute the 8- point IDFT of a sequence.
   X(k) = {7, - 0.707 – j0.707, -j , 0.707 –j0.707, 1 , 0.707 + j0.707, j , -0.707 + j0.707} using
   Radix – 2 DIF FFT algorithm. **(10 Marks)**

Module-4

7 a. Derive an expression for the order of analog Butterworth prototype low pass filter. **(08 Marks)**

   b. Design a digital Butterworth filter using Bilinear transformation method to meet following :
   i)   Stopband attenuation ≤ 1.25 dB at passband edge frequency of 200Hz and
   ii) Stopband attenuation ≥ 15dB at stopband edge frequency of 400Hz. Take sampling
   frequency of 2KHz. **(12 Marks)**

OR

8 a. An analog third order Butterworth low-pass filter has the transfer function
   $H_9(s) = \dfrac{1}{(s+1)(s^2+s+1)}$. Design the corresponding digital filter using impulse invariance
   method. **(08 Marks)**

   b. Obtain direct form – I , direct form – II , Cascade form and Parallel form realization of the
   system defined by
   $H(z) = \dfrac{(z-1)(z-3)(z^2+5z+6)}{(z^2+6z+5)(z^2-6z+8)}$. **(12 Marks)**

Module-5

9 a. Design a linear – phase high pass FIR filter using Hamming window for the following
   desired frequency response.
   $$H_d(e^{jw}) = \begin{cases} 0 & ; \quad |w| < \pi/4 \\ e^{-j2w} & ; \quad \pi/4 \leq |w| \leq \pi \end{cases}.$$ **(08 Marks)**

   b. An FIR filter is defined by difference equation ;
   $y(n) = 2.x(n) + \dfrac{4}{5}x(n-1) + \dfrac{3}{2}x(n-2) + \dfrac{2}{3}x(n-3)$. Find lattice coefficients. Also draw direct
   form and lattice form. **(08 Marks)**

   c. Compare FIR filter with IIR filter. **(04 Marks)**

OR

10 a. Design a linear phase FIR filter using rectangular window for the following desired
   frequency response
   $$H_d(e^{jw}) = \begin{cases} e^{-j2w} & ; \quad |w| < \pi/4 \\ 0 & ; \quad \pi/4 \leq |w| \leq \pi \end{cases}.$$ **(08 Marks)**

   b. Realize the FIR filter whose transfer function is given by
   $H(z) = 1 + \dfrac{3}{4}Z^{-1} + \dfrac{17}{8}Z^{-2} + \dfrac{3}{4}Z^{-3} + Z^{-4}$. Using Direct form – I and Linear phase form. **(08 Marks)**

   c. Explain Gibbs phenomenon. Also mention methods to minimize it. **(04 Marks)**

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