CBCS SCHEME

USN

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 $x(n) = 1 + \cos^2\left(\frac{2\pi n}{N}\right)$; $0 \le n \le N-1$. **(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) $x_1(n) = e^{\frac{j\pi n}{2}} . x(n)$ ii) $x_2(n) = \cos\left(\frac{\pi n}{2}\right).x(n)$ 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.

$$H_d(e^{jw}) = \begin{cases} 0 & ; \quad |w| < \pi/4 \\ e^{-j2w} & ; \quad \pi/4 \le |w| \le \pi \end{cases}$$ **(08 Marks)**

b. An FIR filter is defined by difference equation ;
$y(n) = 2.x(n) + \frac{4}{5}x(n-1) + \frac{3}{2}x(n-2) + \frac{2}{3}x(n-3)$. 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

$$H_d(e^{jw}) = \begin{cases} e^{-j2w} & ; \quad |w| < \pi/4 \\ 0 & ; \quad \pi/4 \le |w| \le \pi \end{cases}$$ **(08 Marks)**

b. Realize the FIR filter whose transfer function is given by
$H(z) = 1 + \frac{3}{4}Z^{-1} + \frac{17}{8}Z^{-2} + \frac{3}{4}Z^{-3} + Z^{-4}$. 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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