USN 10EE64

Sixth Semester B.E. Degree Examination, July/August 2021
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. State and explain the following properties of DFT,
i) Frequency shift property
ii) Circular time convolution property. **(08 Marks)**

b. Obtain the 4 point DFT of the following sequences :
i) $x_1(n) = [1, 1, 2, 2]$ ii) $x_2(n) = (1, 0, 0, 0)$. **(08 Marks)**

c. Let X(k) be 7-point DFT of a length 7. Sequence x(n) given by,
$x(n) = \{-3.1, 2.4, 4.5, -6, 1, -3, 7\}$
If $Y(k) = X((k-4))_7$, find y(n) without computing the IDFT. **(04 Marks)**

2 a. Consider two length – 4 sequences given below,

$$x(n) = \cos\left[\frac{\pi n}{2}\right]; \quad 0 \le n \le 3$$

$$h(n) = 2^n; \qquad 0 \le n \le 3$$

Calculate y(n) = x(n) ④ h(n) circular convolution. **(04 Marks)**

b. Consider a FIR filter with impulse response h(n) = [3, 2, 1, 1]. If the input is, x(n) = [1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1]. Find the output y(n). Use overlap-add method assuming the length of block is 7. **(12 Marks)**

c. The six samples of the 11-point DFT X(k) of a length 11 real sequence are given by X(0) = 12, X(2) = –3.2 + j2, X(3) = 5.3 –j4.1, X(5) = 6.5 + j9, X(7) = - 4.1 + j0.2 and X(10) = –3.1 + j5.2. Determine the remaining 5 samples. **(04 Marks)**

3 a. Determine complex additions and complex multiplications by FFT algorithm and direct DFT. For N = 64, N = 32. Find speed improvement factor. **(10 Marks)**

b. Explain the advantages of FFT algorithm over direct DFT method. **(05 Marks)**

c. Compare DIT FFT and DIF FFT algorithm to determine DFT. **(05 Marks)**

4 a. Determine the DFT of given sequence x(n) = [1, 2, 3, 4, 4, 3, 2, 1] using DIT FFT algorithm. **(10 Marks)**

b. Determine x(n) from given DFT sequences $X_1(k) = [2, 0, 2, 0]$; $X_2(k) = [6, 1 + j, 0, 1 - j]$. **(10 Marks)**

5 a. Design a Butterworth analog high pass filter meeting the following specifications :
i) Maximum passband attenuation = 2dB
ii) Passband edge frequency = 200rad/sec
iii) Minimum stop band attenuation = 20dB
iv) Stopband edge frequency = 100rad/sec. **(10 Marks)**

b. Design a Chebyshev lowpass filter to satisfy the following specifications :
i) Acceptable passband ripple of 2dB
ii) Passband edge frequency 40rad/sec
iii) Stopband attenuation of 20dB or more at 52rad/sec. **(10 Marks)**

6 a. A digital lowpass filter is required to meet the following specifications.
$20\log |H(\omega)|_{\omega} = 0.2\pi \geq 1.9328dB$
$20\log |H(\omega)|_{\omega} = 0.6\pi \geq -13.9794dB$
The filter must have approximally flat frequency response. Find H(z) to meet the above specifications using impulse invariant transformation. (12 Marks)

b. Explain the bilinear transformation, used for transforming an along filter to a digital filter. Also explain the mapping of S-plane to Z-plane in bilinear transformation. (08 Marks)

7 a. Design a low pass filter using rectangular window. Given that cut off frequency $\omega_c \frac{\pi}{2}$ rad/sec and take M = 11. Find the values of h(n). (12 Marks)

b. The frequency response of an FIR filter is given by,
$H(\omega) = e^{-3\omega}(1 + 1.8\cos 3\omega + 1.2\cos 2\omega + 0.5\cos\omega)$
Determine the coefficients of the impulse response h(n) of the FIR filter. (08 Marks)

8 a. Obtain the direct form – I and form – II structure for the filter given by system function :

$$H(z) = \frac{1 + 0.4z^{-1}}{1 - 0.5z^{-1} + 0.06z^{-2}}.$$ (06 Marks)

b. Realize the digital filter with system function given by,

$$H(z) = 1 + \frac{1}{2}z^{-1} + \frac{1}{3}z^{-2} + \frac{1}{7}z^{-3} + \frac{1}{3}z^{-4} + \frac{1}{2}z^{-5} + z^{-6}.$$ (06 Marks)

c. Obtain a parallel realization for the system represented by the following system function :

$$H(z) = \frac{1 + \frac{1}{4}z^{-1}}{\left(1 + \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}\right)}.$$ (08 Marks)

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