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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,

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

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

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.

$20\log|H(\omega)|_{\omega} = 0.2\pi \geq -1.9328\text{dB}$

$20\log|H(\omega)|_{\omega} = 0.6\pi \geq -13.9794\text{dB}$

The filter must have approximately 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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