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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,

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

$$h(n) = 2^n; 0 \leq n \leq 3$$
 Calculate $y(n) = x(n) \circledast h(n)$ 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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 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 analog 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)
