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17EC52

Fifth Semester B.E. Degree Examination, July/August 2022
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. Obtain a relationship to provide the reconstruction of the periodic signal $x_p(n)$ from the samples of the spectrum X(W). **(10 Marks)**

b. Define DFT of a N point sequence x(n) and IDFT of a N point sequence X(K). Let x(n) is a finite duration sequence of length N or less. Show that z{x(n)} = X(z) can be expressed as a function of X(K). **(10 Marks)**

OR

2 a. Explain the concept of DFT and IDFT as a linear transformation. Using definition of IDFT, find IDFT of the sequence: X(K) = {6, -2 + 2j, -2, -2 -2j}. **(10 Marks)**

b. By means of DFT and IDFT, determine the sequence $x_3(n)$ corresponding to the circular convolution of the sequence $x_1(n)$ and $x_2(n)$. Where $x_1(n) = \{\underset{\uparrow}{2}, 1, 2, 1\}$ and $x_2(n) = \{\underset{\uparrow}{1}, 2, 3, 4\}$. **(07 Marks)**

c. If x(k) is the DFT of N point real sequence x(n), show that X(0) is real and $X\left(\frac{N}{2}\right)$ is real. **(03 Marks)**

Module-2

3 a. State and prove time reversal and circular convolution property of DFT. **(08 Marks)**

b. The 4 point DFT of a real sequence x(n) is X(K) = {1, j, 1, -j}. Using properties of DFT, find DFT of the following sequence.
- i) $x_1(n) = (-1)^n x(n)$
- ii) $x_2(n) = x((n + 1))_4$
- iii) $x_3(n) = x(4 - n)$. **(06 Marks)**

c. With a neat diagram, explain overlap and save method of linear filtering. **(06 Marks)**

OR

4 a. Find the output y(n) of a filter whose impulse response is h(n) = {1, 1, 1} and input signal x(n) is $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using overlap and add method. **(08 Marks)**

b. Prove periodicity and symmetry of twiddle factor. What is in place computation in FFT algorithm? **(04 Marks)**

c. Compare computational requirement of direct computation of DFT of a complex valued sequence x(n) of N = 32 points against FFT algorithm. **(08 Marks)**

Module-3

5 a. Find 8-point DFT of the sequence x(n) = n + 1; $0 \le n \le 7$ using DIF FFT algorithm. **(10 Marks)**

b. Develop Radix-2 DIT FFT algorithm for N = 8. **(10 Marks)**

OR

6 a. Determine 8-point IDFT of the sequence
X(k) = {6, -0.707 – 1.707j, 1 - j, 0.707 + 0.293j, 0, 0.707 – 0.293j, 1 + j, -0.707 + 1.707j} using DIF-FFT algorithm. **(10 Marks)**

b. Develop direct form II structure for Geortzel algorithm to find DFT. **(10 Marks)**

Module-4

7 a. Derive an expression to get order N and cut off frequency Ω_c of a analog Butterworth filter. **(10 Marks)**

b. Design an analog bandpass filter using Butterworth approximation to meet the following specifications:
i) -3.01dB upper and lower cutoff frequency of 50Hz and 20kHz.
ii) Stopband attenuation of atleast 20dB at 20Hz and 45kHz
iii) A monotonic frequency response. **(10 Marks)**

OR

8 a. A digital Lowpass filter is required to meet the following specifications:
i) Monotonic passband and stopband.
ii) -3dB cutoff frequency of 0.5π rad.
iii) Stopband attenuation of atleast 15dB at 0.75π rad.
Find system function H(z). Use Bilinear transformation. **(10 Marks)**

b. Obtain parallel and cascade realization of the IIR system

$$H(z) = \frac{1 + \frac{1}{3}z^{-1}}{1 - \frac{3}{4}z^{-1} + \frac{1}{8}z^{-2}}.$$ **(10 Marks)**

Module-5

9 a. The desired frequency response of a lowpass filter is given by

$$H_d(e^{jw}) = H(w) = \begin{cases} e^{-j3w} & |w| < \frac{3\pi}{4} \\ 0 & \frac{3\pi}{4} < |w| < \pi \end{cases}$$

Determine the frequency response of the FIR filter if hamming window is used with N = 7. **(10 Marks)**

b. Realize linear-phase FIR filter having the following impulse response

$$h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4).$$ **(05 Marks)**

c. Compare IIR system with FIR system. **(05 Marks)**

OR

10 a. A filter is to be designed with the following desired frequency response:

$$H_d(w) = \begin{cases} 0 & -\pi/4 < |w| < \pi/4 \\ e^{-j2w} & \pi/4 < |w| < \pi \end{cases}$$

Find the frequency response of the FIR filter using rectangular window of length N = 5. **(10 Marks)**

b. Consider a 3-stage FIR filter lattice structure having the coefficients $K_1 = 0.65$, $K_2 = -0.34$ and $K_3 = 0.8$. Evaluate its impulse response by tracing a unit impulse δ(n) at its input through the lattice structure. Also, draw its direct form structure. **(10 Marks)**

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