CBCS SCHEME

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17EC52

Fifth Semester B.E. Degree Examination, Feb./Mar.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. Define DFT. Establish the relationship of DFT with z-transform and DTFT. **(05 Marks)**

b. Compute the DFT of the sequences :

i) $x(n) = \cos\frac{2\pi}{N}k_0 n$

ii) $x_2(n) = \delta(n) + 2\delta(n-1) + 3\delta(n-2) + 4\delta(n-3)$. **(10 Marks)**

c. Determine the inverse DFT of the sequence y(k) = [0, 2 – 2j, 0, 2 + 2j]. **(05 Marks)**

OR

2 a. Evaluate the circular convolution of the following two sequences using concentric circle method.

$x_1(n) = [2, 1, 2, 1, 3]$, $x_2[n] = [1, 2, 3, 4]$. **(10 Marks)**

b. The first five points of eight point DFT of a real valued sequence are (0.25, 0.125 – j0.30, 0, 0.125 – j0.05, 0).

Determine :

i) Remaining points ii) x(0) iii) x(4) iv) $\sum_{n=0}^{7} x(n)$ v) $\sum_{n=0}^{7} |x(n)|^2$. **(10 Marks)**

Module-2

3 a. State and prove the following properties of DFT

i) Circular time reversal

ii) Circular frequency shift

iii) Parseval's theorem. **(12 Marks)**

b. If X(k) is the DFT of the sequence x(n). Determine the N point DFT of the sequences

$x_c(n) = x(n)\cos\frac{2\pi k_0 n}{N}$ and

$x_s(n) = x(n)\sin\frac{2\pi k_0 n}{N}$ interms of x(k). **(08 Marks)**

OR

4 a. How many complex multiplications and additions required for computing DFT using direct DFT and FFT algorithm for N = 512. **(06 Marks)**

b. Consider a FIR filter with impulse response h(n) = [3, 2, 1]. If the input sequence x(n) = [2, 1, –1, –2, –3, 5, 6, –1, 2, 0, 2, 1] using overlap save method. Use 8 point circular convolution. **(14 Marks)**

Module-3

5 a. Develop 8 – point DIT – FFT algorithm. **(10 Marks)**

b. Compute DFT of the sequence x(n) = [1, 2, 3, 4, 4, 3, 2, 1] using DIF-FFT algorithm. **(10 Marks)**

OR

6 a. Perform circular convolution of the sequences x(n) = [1, 2, 3, 4] and h(n) = [1, 1, 1, 1,] using DIF FFT algorithm. (10 Marks)

b. With relevant equations, explain Goertzel and chirp Z – transform algorithm. (10 Marks)

Module-4

7 a. Design an IIR lowpass analog butter worth filter that meets following specification.

$$0.8 \le |H(j\Omega)| \le 1 \quad \text{for} \quad 0 \le \Omega \le 0.2\pi$$
$$|H(j\Omega)| \le 0.2 \quad \text{for} \quad 0.6\pi \le \Omega \le \pi$$

(12 Marks)

b. Let $H(s) = \frac{1}{5^2 + \sqrt{2}s + 1}$ represent the transfer function of low pass filter with a passband of 1 rad/sec. Use frequency transformation to find the transfer function of the following analog filters.

i) A lowpass filter with passband of 10 rad/sec

ii) A high pass filter with cut off frequency of 10 rad/sec. (08 Marks)

OR

8 a. Realize the filter described the transfer function :

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

Using cascade and parallel from structure. (10 Marks)

b. The system function of an analog filter is given as $H_a(s) = \frac{1}{(s+1)(s+2)}$. Obtain H(z) using impulse invariant and bilinear transform method. take sampling frequency of 5 samples/sec. (10 Marks)

Module-5

9 a. Realize FIR filter with impulse response h(n) = [1, 2, 3, 4, 3, 2, 1] using direct form and linear phase structure. (10 Marks)

b. Draw direct form I and Lattice structure for the filter given by

$$y(n) = x(n) + \frac{2}{5}x(n-1) + \frac{3}{4}x(n-2) + \frac{1}{3}x(n-3).$$

(10 Marks)

OR

10 a. Name any four types of windows used in the design of FIR filters. Write the analytical equations and draw the magnitude response characteristics of each window. (08 Marks)

b. Determine the filter coefficients $h_d(n)$ for the desired frequency response of a lowpass filter given by

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega} & \text{for} \quad \frac{-\pi}{4} \le \omega \le \frac{\pi}{4} \\ 0 & \text{for} \quad \frac{\pi}{4} \le |\omega| \le \pi \end{cases}$$

Also determine h(n) and frequency response $H(e^{j\omega})$ using Hamming window. (12 Marks)

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