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

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

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

   $x_s(n) = x(n)\sin\dfrac{2\pi k_0 n}{N}$ 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.
$$0.8 \leq |H(j\Omega)| \leq 1 \quad \text{for} \quad 0 \leq \Omega \leq 0.2\pi$$
$$|H(j\Omega)| \leq 0.2 \quad \text{for} \quad 0.6\pi \leq \Omega \leq \pi$$
   (12 Marks)

    b. Let $H(s) = \dfrac{1}{5^2 + \sqrt{2}s + 1}$ 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 $H_a(s) = \dfrac{1}{(s+1)(s+2)}$. 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
$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega} & \text{for} \quad \dfrac{-\pi}{4} \leq \omega \leq \dfrac{\pi}{4} \\ 0 & \text{for} \quad \dfrac{\pi}{4} \leq |\omega| \leq \pi \end{cases}$$

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

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