# CBCS SCHEME

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**18EC52**

## Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
## Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

**Note:** ***Answer any FIVE full questions, choosing ONE full question from each module.***

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.

### Module-1

1 a. Prove that the sampling of Fourier transform of a sequence x(n) results of N point DFT using which both sequence and the transform can be reconstructed. **(08 Marks)**

b. Find N point DFT of the sequence $x(n) = \text{Cos}(n\omega_0)$ where $\omega_0 = \frac{2\pi K_0}{N}$ **(04 Marks)**

c. For $x(n) = \{1, -2, 3, -4, 5, -6\}$, without computing DFT, find

i) $\sum_{k=0}^{5} x(k)$ ii) x(3) iii) $\sum_{k=0}^{5} |x(k)|^2$ iv) $\sum_{k=0}^{5} x(k)(-1)^k$ **(08 Marks)**

**OR**

2 a. Consider the finite length sequence $x(n) = \delta(n) + 2\delta(n-5)$

i) Find the 10 point DFT of x(n)

ii) Find the sequence that has a DFT $y(k) = e^{\frac{j6\pi k}{10}} \times (k)$, where x(k) is the 10 point DFT of x(n)

iii) Find the 10 point sequence y(n) that has a DFT y(k) = x(k)w(k) where x(k) is the 10 point DFT of x(n) and w(k) is the 10 point DFT of w(n) given by w(n) = u(n) – (n – 7) **(12 Marks)**

b. Find the energy of 4 point sequence

$x(n) = \text{Sin}\left(\frac{2\pi}{N} n\right), 0 \le n \le 3.$ **(04 Marks)**

c. The 4 point DFT of a real sequence x(n) is x(k) (1, j, 1, –j). Using the properties of DFT, find the DFT of following sequence:

i) $x_1(n) = (-1)^n x(n)$ ii) $x_2(n) = x(4 - n)$ **(04 Marks)**

### Module-2

3 a. A long sequence x(n) is filtered through a filter with impulse response h(n) to yield output y(n). If input x(n) = {1, 0, 1, –2, 1, 2, 3, –1, 0, 2} and h(n) = {1, –1, 2}, compute y(n) using overlap save technique, Use 6 point circular convolution. **(08 Marks)**

b. Find 8 point DFT of x(n) = n + 1 using DIT-FFT without computing DFT of y(n), find y(k) of $y(n) = x(-n))_8$. **(12 Marks)**

**OR**

4 a. Determine the output of an LTI system using circular convolution for x(n) = {1, 1}, h(n) = {1, 0, 1}. **(03 Marks)**

b. For 512 point DFT/FFT computation , determine

i) Number of complex multiplications and complex additions in DFT and FFT computation

ii) Speed improvement factor

iii) Number of real multiplications and additions in DFT computation

iv) Number of stages and butterflies needed in FFT computation **(07 Marks)**

c. Find the circular convolution of the sequence x(n) = (2, 3, 2, 2), y(n) = (1, 1, 5, 3) using DIF-FFT algorithm. Verify the same using time domain approach. **(10 Marks)**

## Module-3

5 a. Convent the lattice structure of FIR filter defined by K1 = 0.65, K2 = 0.341, K3 = 0.8 to direct form structure. Draw both lattice and direct form structure. **(10 Marks)**

b. Design a FIR BPF for lower cutoff frequency 2 rad/s upper cutoff frequency 3rad/s and m = 7. Use Hamming windows. Find frequency response and H(z). **(10 Marks)**

**OR**

6 a. Design a linear phase HPF using Hanning window for the following desired frequency response $H(w)=\begin{cases} e^{-j5w} & \frac{\pi}{4} \le |w| \le \pi \\ 0 & |w| \le \frac{\pi}{4} \end{cases}$ **(08 Marks)**

b. Obtain the cascade realization of
$H(z) = (1 + 2z^{-1} + 5z^{-2} + 5z^{-3} + 2z^{-4} + z^{-5})(2 + z^{-1} + 3z^{-2})$ **(04 Marks)**

c. Determine the coefficient h(n) of linear phase FIR filter of length m = 15 which has a symmetric unit impulse response and a frequency response that satisfies
$H_r\left(\frac{2\pi k}{15}\right)=\begin{cases} 1 & K=0,1,2,3 \\ 0 & K=4,5,6,7 \end{cases}$ **(08 Marks)**

## Module-4

7 a. Let H(s) $\frac{1}{s^2+s+1}$ represent the transfer function of low pass filter with passband of 1rad/sec. Use frequency transformation to find the transfer function of i) HPF with passband edge frequency of 100 rad/sec ii) BPF with pass band of 10rad/sec and a center frequency of 100 rad/s **(04 Marks)**

b. Design a second order digital BPF Butterworth filter with the following specifications Butterworth filter with the following specifications
   i) Upper cutoff frequency = 2.6KHz
   ii) Lower cutoff frequency = 2.4KHz
   iii) Sampling frequency = 8000Hz **(08 Marks)**

c. Find DF-I and DF-II realization of
$$H(z)=\frac{8z^3-4z^2+11z-2}{\left(z-\frac{1}{4}\right)\left(z^2-z+\frac{1}{2}\right)}$$ **(08 Marks)**

**OR**

8 a. Design a digital IIR Butterworth HPF with frequency specification given by
   i) Monotonic passband with cutoff frequency 1000Hz
   ii) Monotonic stopband with edge frequency 350Hz
   iii) Stopband attenuation $\ge$ 10dB
   iv) Sampling rate 5KHz **(08 Marks)**

b. Obtain DF-I and DF-II realization for
y(n) = 0.75 y(n – 1) – 0.125 y(n – 2) + 6x(n) + 7x(n – 1) + x (n – 2). **(08 Marks)**

c. Discuss how analog filter is mapped on to digital filter using Bilinear Transformation and comment on its stability. **(04 Marks)**

## Module-5

9 a. Explain the basic architecture of TMS320C3X floating point DSP. (08 Marks)

b. Given the FIR filter with passband and gain of 2 and input being half of the range develop the DSP implementation equations in Q15 fixed point system
$y(n) = -0.36\, x(n) + 1.6x(n-1) + 0.36\, x(n-2)$ (06 Marks)

c. With block diagram, explain DSP processors based on Hardvard architecture. (06 Marks)

**OR**

10 a. Discuss briefly the following special Digital signal processor hardware units
i) Multiplier and Accumulator unit
ii) Address generators (08 Marks)

b. Explain the basic architecture of TMS320C54X family DSP with neat diagram. (08 Marks)

c. i) Find the signed Q15 representation for the decimal number $-0.160123$
ii) Convert $-2.5$ to 1EEE single precision format. (04 Marks)

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