CBCS SCHEME

USN

21EC42

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2025
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. Find the 16 point DFT of a signal

$$x(n) = \begin{cases} \frac{1}{2} & n \le 0 \\ 1 & 1 \le n \le 15 \end{cases}$$ **(08 Marks)**

b. With neat diagram, explain frequency domain sampling and reconstruction of discrete time signals. **(08 Marks)**

c. The first fiver values of an 8 point DFT of real valued sequence are (4, 1-j1 , 0 , 1+j2, 0}. Find the remaining values of the DFT. **(04 Marks)**

OR

2 a. Determine 8 point DFT of x(n) = [1,1,1,1,0,0,0,0]. **(10 Marks)**

b. Determine 4 point circular convolution between $x_1(n)$ = [1,2,2,1] and $x_2(n)$ = [1,1] using DFT and IDFT method. **(10 Marks)**

Module-2

3 a. State and prove Parseval's theorem in DFT. **(06 Marks)**

b. Using overlap save method, compute y(n) of a FIR filter with impulse response h(n) = [3, 2, 1] to an input x(n) = [2, 1, -1, –2, -3, 5, 6, –1, 2, 0, 2, 1]. Use only 8-point circular convolution. **(08 Marks)**

c. For the sequences $x_1(n) = \cos\left(\frac{2\pi n}{N}\right)$ and $x_2(n) = \sin\left(\frac{2\pi n}{N}\right)$, $0 \le n \le N-1$, determine N point circular correlation of $x_1(n)$ and $x_2(n)$. **(06 Marks)**

OR

4 a. Using over lap add method, compute y(n) of a FIR filter with impulse response h(n) = [1,2,1] to an input sequence x(n) = [1, 2 , 3, 3, 2, 1, –1, –2 , –3 , 5, 6, -1, 2 , 1], use only 6-point circular convolution. **(10 Marks)**

b. Find the DFT of a sequence x(n) = [1, 2, 3, 4, 4, 3, 2, 1] using radix 2 DIT – FFT algorithm. **(10 Marks)**

Module-3

5 a. Design a FIR filter with a desired frequency response

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

. Also obtain the frequency response. **(10 Marks)**

b. A FIR filter is given by difference equation

$y(n) = x(n) + \frac{2}{5}x(n-1) + \frac{3}{4}x(n-2) + \frac{1}{3}x(n-3)$. Draw the corresponding direct Form – I and lattice structure. **(10 Marks)**

OR

6 a. Given $H(z) = (1 + 0.6z^{-1})^5$. Realize in direct form and cascade of first and second order sections. **(10 Marks)**

b. Determine filter coefficients h(n) of a FIR filter with a desired frequency response.

$$H_d(w) = \begin{cases} e^{-2w} & -\pi/4 \le w \le \pi/4 \\ 0 & \pi/4 \le |w| \le \pi \end{cases}$$ use Hamming window. **(10 Marks)**

Module-4

7 a. Derive the expression for the order of Butterworth filter. **(06 Marks)**

b. The system function of the analog filter is given as $H_a(S) = \frac{S+0.1}{(S+0.1)^2+16}$. Obtain the system function of the digital filter using bilinear transformation. Assume T = 2 seconds. **(06 Marks)**

c. Design a digital Butterworth filter with a maximum pass band attenuation 3.01 dB at pass band edge frequency 500Hz and stop band attenuation of 15 dB at stop band edge frequency 750 Hz. Sampling rate of 2 KHz. **(08 Marks)**

OR

8 a. A system is specified by its transfer function

$$H(z) = \frac{(z-1)(z-2)(z+1)z}{\left[z-\left(\frac{1}{2}+j\frac{1}{2}\right)\right]\left[z-\left(\frac{1}{2}-j\frac{1}{2}\right)\right]\left[z-j\frac{1}{4}\right]\left[z+j\frac{1}{4}\right]}$$ realize the system in the direct form - I and direct form – II. **(10 Marks)**

b. A Butterworth low pass filter has to meet the following specifications :

i) Pass band ripple and edge frequency of 1dB, 100 π rad/sec.

ii) Stop band attenuation and edge frequency of 35 dB, 1000 π rad/sec respectively at the sampling rate of 2000 samples/sec. Applying BLT technique, determine H(z). **(10 Marks)**

Module-5

9 a. With a neat diagram, explain the Harvard architecture used in DS processors. **(07 Marks)**

b. Explain dedicated MAC computation in DSP processor with a block diagram. **(05 Marks)**

c. Convert the following decimal numbers into the floating point representation :

i) 0.640492×2^{-2} ii) -0.638454×2^5.

Use 4 bits to represent exponent and 12 – bits for mantissa. **(08 Marks)**

OR

10 a. With a neat diagram, explain basic architecture of TMS320C54X family digital signal processors. **(10 Marks)**

b. Describe the IEEE single precision floating point format used in DSP processors. **(05 Marks)**

c. Find the signed Q – 15 representation for the decimal number 0.560123. **(05 Marks)**

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