

**III B. Tech II Semester Regular Examinations, July -2023**  
**DIGITAL SIGNAL PROCESSING**  
 (Electronics and Communication Engineering)

Time: 3 hours

Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**  
 All Questions Carry Equal Marks

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**UNIT-I**

1. a) Find the linear, invariance and causality property of given system represented by : [7M]  
 $y(n) = x(n) - ax(n-1)$ .  
 b) Find the convolution of the signals  $x(n) = (a)^n u(n)$  and  $h(n) = (b)^n u(n)$ . [7M]  
 (OR)
2. a) Write the properties of ROC of  $X(z)$ . [7M]  
 b) Find the magnitude and phase response for the system characterized by the difference equation  $y(n) = \frac{1}{2}x(n) + x(n-1) + \frac{1}{2}x(n-2)$ . [7M]

**UNIT-II**

3. a) State and prove the following properties of DFT [7M]  
 i) circular frequency shift ii) Parseval's Theorem.  
 b) Develop a DIF FFT algorithm and draw its flow diagram. [7M]  
 (OR)
4. a) Find the DFT of i)  $x^*(n)$  ii)  $x^*(-n)$  iii)  $\text{Re}\{x(n)\}$  iv)  $\text{Im}\{x(n)\}$  [7M]  
 b) Find the IDFT of the sequence using DIF algorithm  $Y(k) = \{10, -2-j2, -2, -2+j2\}$  [7M]

**UNIT-III**

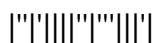
5. a) Determine the digital filter Transformation from the following analog T.F [7M]  
 $H_a(s) = 1 / (s+0.5)(s^2+0.5s+2)$  using Impulse Invariant Method. Assume  $T_s = 1$  sec.  
 b) With an example explain the design procedure for Butterworth filter [7M]  
 (OR)
6. a) Design a digital Butterworth filter that satisfies the following specifications : [7M]  
 $0.9 < |H(jw)| \leq 1$ , for  $0 \leq w \leq \pi/2$   
 $|H(jw)| < 0.2$ , for  $3/4 \pi \leq w \leq \pi$  using BLT. Assume  $T_s = 1$  sec  
 b) Explain basic structures and Transposed forms of IIR systems with suitable examples. [7M]

**UNIT-IV**

7. a) Design a 7-tap linear FIR Digital filter with a cut-off frequency of  $\pm 3 \pi/4$  rad [7M]  
 using hamming window.  
 b) Obtain the parallel realization of the system described by the difference equation [7M]  
 $y[n] - \frac{13}{12}y[n-1] + \frac{9}{24}y[n-2] - \frac{1}{24}y[n-3] = x[n] + 2x[n-1]$   
 (OR)
8. a) Explain the need for the use of window sequence in the design of FIR filter. Describe [7M]  
 the window sequence generally used and compare the properties.  
 b) Determine the lattice filter representation for the following FIR filter: [7M]  
 $H(z) = 1 + 7/8 z^{-1} + 11/16 z^{-2} + 1/4 z^{-3}$

**UNIT-V**

9. a) Discuss the salient features and special addressing modes of Digital signal processors. [7M]  
b) Explain briefly the following for TMS320C5X: i) Flags available in status register ii) Parallel Logic Unit. [7M]
- (OR)
10. a) Explain in detail the architecture of TMS320C5X processor. [7M]  
b) With neat block diagram, explain about the pipelining in DSP processors. [7M]



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**UNIT-I**

1. a) Determine the Inverse Z-Transform of:  $X(Z)=1/(1-Z^{-1})(1-Z^{-1})^2$ . [7M]  
 b) Define Discrete time systems, explain the classification with suitable examples [7M]  
 (OR)
2. a) Find the frequency response  $H(e^{j\omega})$  of the linear time-invariant system whose input and output satisfy the difference equation: [7M]  
 $y[n] - \frac{1}{2}y[n-1] = x[n] + 2x[n-1] + x[n-2]$   
 b) A causal LTI system is defined by the difference equation: [7M]  
 $2y(n)-y(n-2)=x(n)+3x(n-2)+2x(n-3)$ . Find the frequency response  $H(e^{j\omega})$ , magnitude response and phase response.

**UNIT-II**

3. a) Define DFT and then state and prove properties of DFT. [7M]  
 b) Given  $X(K) = \{36, -4+j9.565, -4+j4, -4+j1.656, -4, -4-j1.656, -4-j4, -4-j9.656\}$  [7M]  
 find  $x(n)$  using FFT algorithm  
 (OR)
4. a) Show how the complexity of computing DFT can be reduced by Radix-2 DIF algorithm with suitable diagrams. [7M]  
 b) Determine the 8 point DFT of the sequence  $X(n) = \begin{cases} 1 & -4 \leq n \leq 4 \\ 0 & \text{otherwise} \end{cases}$  [7M]

**UNIT-III**

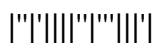
5. a) For the analog transfer function  $H(s) = 2 / \{(s+2)(s+3)\}$ . Determine  $H(z)$  using impulse invariance method. Assume  $T = 1$  sec [7M]  
 b) Determine the order and poles of type-I chebyshev low pass filter for the given specifications: [7M]  
 $\alpha_p = 1$  dB,  $\alpha_s = 40$  dB,  $\Omega_p = 1000\pi$  rad/sec  $\Omega_s = 2000\pi$  rad/sec.  
 (OR)
6. a) Design a digital second order Low-Pass Butterworth filter with cut-off frequency 2.2KHz using Bilinear Transformation. Sampling rate 8 KHz [7M]  
 b) Compare Impulse invariant and bilinear transformation methods. [7M]

**UNIT-IV**

7. a) Design an FIR low pass filter satisfying the following specifications [7M]  
 $\alpha_p \leq 1$  dB;  $\alpha_s \geq 44$  dB,  $w_p = 20$  rad/sec,  $w_s = 30$  rad/sec,  $w_{sf} = 100$  rad/sec  
 b) Given a 3-stage lattice FIR filter with coefficients,  $k_1=(1/4)$ ;  $k_2=(1/2)$ ;  $k_3=(1/3)$ ; [7M]  
 Determine the FIR filter coefficients for the direct form structure.  
 (OR)
8. a) Design a low pass filter using Hanning window with a cutoff frequency of 0.9 radians/sec and  $N=6$ . Draw the filter structure and plot its spectrum. [7M]  
 b) Find the structural representation in direct and transposed form for system [7M]  
 described by the difference equation.  
 $y(n) = x(n) - 0.3 x(n-1) - 0.7 x(n-2) + 0.6 y(n-1) + 0.8 y(n-2)$

**UNIT-V**

9. a) Explain in brief memory access schemes in DSP processors. [7M]  
b) Draw the pipelined MAC configuration to perform convolution operation and Explain with neat timing diagrams. [7M]
- (OR)
10. a) Explain how the VLIW architecture is improving the performance of DSP processor. [7M]  
b) What is meant by bit reversed addressing mode? What is the application for which this addressing mode is preferred? [7M]



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**UNIT-I**

1. a) Define an LTI System and show that the output of an LTI system is given by the convolution of Input sequence and impulse response. [7M]
- b) Check the following filter for time invariant, causal and linear [7M]  
i)  $y(n) = (n-1)(n+1)$  ii)  $y(n) = x(n-2)$

(OR)

2. a) Explain the concept of stability and causality with examples. [7M]
- b) An LTI system is described by the equation  $y(n) = x(n) + 0.81x(n-1) - 0.81x(n-2) - 0.45y(n-2)$ . Determine the transfer function of the system. Sketch the poles and zeroes on the Z-plane [7M]

**UNIT-II**

3. a) Perform i) Linear Convolution ii) Circular Convolution for the following sequence [7M]  

$$x(n) = \begin{cases} 1, & n=0 \\ 0.5, & n=1 \\ 0, & \text{otherwise} \end{cases} \quad h(n) = \begin{cases} 0.5, & n=0 \\ 1, & n=1 \\ 0, & \text{otherwise} \end{cases}$$
 And Show when they are equal.

- b) Develop a radix-2 DIT FFT algorithm for evaluating the DFT for  $N = 8$ . [7M]

(OR)

4. a) Explain how DFT provides an alternative approach to time domain convolution through linear filtering. [7M]
- b) Find the DFT of the given sequence by using DIF FFT. [5+5]  $x(n) = \{0.5, 1.5, -0.5, -0.5\}$  [7M]

**UNIT-III**

5. a) Design an analog filter for the following specifications: [7M]

$$-1 < |H(j\Omega)|_{\text{db}} \leq 0, \text{ for } 0 \leq \Omega \leq 1404\pi \text{ rad/s}$$

$$|(H(j\Omega))|_{\text{db}} < -60, \text{ for } \Omega \geq 8268\pi \text{ rad/s}$$

- b) Discuss the impulse invariant method and also explain its limitations. [7M]

(OR)

6. a) Explain the procedure for designing Analog filters using the Chebyshev approximation. [7M]
- b) Using Bilinear transformation, design a high pass filter, monotonic in pass band with cutoff frequency of 1000 Hz and down 10dB at 350 Hz. The sampling frequency is 5000 Hz. [7M]

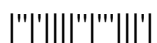
**UNIT-IV**

7. a) Explain the canonical form of digital filter realization with suitable examples. [7M]
- b) Design a FIR digital low-pass filter with a cutoff frequency of 1 kHz and a sampling rate of 4 kHz with 7 samples using Fourier series method. [7M]

(OR)



8. a) Using a Hanning window technique, design a low pass filter with pass band gain of unity, cut-off frequency of 1000Hz and working at a sampling frequency of 5 KHz. [7M]  
The length of the impulse response should be 7
- b)  $H(z) = \left(\frac{2}{3}\right)z + 1 + \left(\frac{2}{3}\right)z^{-1}$  [7M]  
Realize the system function by linear phase FIR structure.
- UNIT-V**
9. a) Write about the architectural features of TMS320C5X DSP processor. [7M]  
b) How much memory can be interfaced to TMS320C5X? Explain in detail its Memory mapping. [7M]
- (OR)
10. a) Explain the special addressing modes of DSP with suitable examples. [7M]  
b) Explain the i) Bus Structure ii) On-chip peripherals in a TMS320C5X DSP processor. [7M]



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**UNIT-I**

1. a) Determine the impulse response  $h(n)$  for the system described by the second order difference equation  $y(n) - 4y(n-1) + 4y(n-2) = x(n-1)$  [7M]  
 b) Establish the relation between DFT and Z-transform. [7M]  
 (OR)
2. a) Determine the stability of the following systems using Z-transform: [7M]  
 i)  $h(n) = 2^n u(n)$  ii)  $h(n) = 5^n u(3-n)$   
 b) Determine the causal signal  $x(n)$  having the Z-transform [7M]  
 $X(Z) = (Z^2 + Z) / [(Z - 1/2)^2 (Z - 1/4)]$

**UNIT-II**

3. a) Find the DFT of a sequence  $y[n] = \{1, 2, 3, 4, 4, 3, 2, 1\}$  using: [7M]  
 i) DIT algorithm ii) DIF algorithm.  
 b) Let  $x(n)$  be a real valued sequence with N-points and Let  $X(K)$  represent its DFT, with real and imaginary parts denoted by  $X_R(K)$  and  $X_I(K)$  respectively. So that  $X(K) = X_R(K) + jX_I(K)$ . Now show that if  $x(n)$  is real,  $X_R(K)$  is even and  $X_I(K)$  is odd. [7M]  
 (OR)
4. a) Compute 4-point DFT of a sequence  $x(n) = \{0, 1, 2, 3\}$  using DIT algorithm. [7M]  
 b) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation-in-time algorithm. [7M]

**UNIT-III**

5. a)  $H(s) = \frac{2}{(s+1)(s+2)}$  with  $T=1$  Sec and find  $H(z)$ . [7M]  
 Apply bilinear transformation to  
 b) For the given specifications design an analog Butterworth filter. [7M]  
 $0.9 \leq |H(j\Omega)| \leq 1$  for  $0 \leq \Omega \leq 0.2\pi$   
 $|H(j\Omega)| \leq 0.2$  for  $0.4\pi \leq \Omega \leq \pi$   
 (OR)
6. a) Using the bilinear transform, design a high pass filter, monotonic in passband with cutoff frequency of 1000 Hz and down 10 dB at 350 Hz. The sampling frequency is 5000 Hz. [7M]  
 b) What are the steps to design an analog Chebyshev High pass filter. [7M]

**UNIT-IV**

7. a) Explain the design procedure of linear phase FIR filter using Fourier series method. [7M]  
 b) Consider a second order IIR filter with: [7M]  
 $H(z) = \frac{1}{(1 - 0.5z^{-1})(1 - 0.45z^{-1})}$   
 Find the effect on quantization on pole locations of the given system function in direct form and in cascade form. Assume  $b=3$  bits.  
 (OR)
8. a) Explain the type -1 FIR filter design procedure using frequency sampling method. [7M]  
 b) Explain how reduction of product round-off error is achieved in digital filters? [7M]

**UNIT-V**

9.   a)   Discuss various interrupt types supported by TMS320C5X processor. [7M]  
      b)   Explain the memory access schemes in P-DSP's. [7M]  
          (OR)
10.   a)   Explain the functioning of Multiplier and Multiplier Accumulator in DSP [7M]  
          processor.  
      b)   Explain the functions of on-chip peripherals in a DSP processor. [7M]

