III B. Tech II Semester Regular Examinations, June-2022

DIGITAL SIGNAL PROCESSING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 75

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

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UNIT-I

1\. a) Define periodic signal. Determine periodicity of the following signals: [8M]

(i) $x(n) = cos^2\ \frac{\pi}{8}n)$ (ii) $x(n) = cos\ \frac{\pi}{3}n) + 3\ sin\ \frac{\pi}{4}n)$

b) Find the step response of a discrete-time LTI system whose difference equation is given by [7M]

$$y(n) = y(n-1) + 0.5y(n-2) + x(n) + x(n-1)$$

(OR)

2\. a) Define and explain the following systems with an example: [8M]

(i) Causal and non-causal (ii) Time-invariant and time-variant

b) Find the magnitude and phase response of the LTI system with [7M]

$$h(n) = \delta(n) - \delta(n-1)$$

UNIT-II

3\. a) Determine the discrete Fourier series coefficients of the periodic signal $x(n) = \left(Cos\frac{2\pi}{3}n\right)\left(Sin\frac{2\pi}{5}n\right)$. Also, sketch its magnitude spectrum. [8M]

b) How FFT algorithm improves the speed of computation? Explain with an example. [7M]

(OR)

4\. a) State and prove any two properties of DFT. [8M]

b) Find the 4-point DFT of the sequence $x(n) = \{2, 1, 4, 3\}$ by using DIF FFT algorithm? Also, plot its magnitude and phase spectra. [7M]

UNIT-III

5\. a) Obtain the 4^{th} order transfer function of normalized Butterworth low pass filter. [8M]

b) Draw the parallel form realization of a system with system function [7M]

$$H(z) = \frac{(1 - z^{-1})^3}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{1}{8}z^{-1}\right)}$$

(OR)

6. a) Design a digital Butterworth band pass filter using bilinear transformation for the following specifications: [10M]
Lower stop band edge = 25 Hz; Lower pass band edge =100 Hz;
Upper pass band edge =150 Hz; Upper stop band edge = 225 Hz;
Stop band attenuation = 18 dB; Pass band ripple = 3 dB;
Sampling frequency = 500 Hz.

   b) List out the requirements for conversion of stable analog filter into stable digital filter. [5M]

UNIT-IV

7. a) Determine the frequency response of FIR filter with N is odd and symmetric impulse response. [8M]

   b) Explain the concept of Gibbs phenomenon in FIR filters. [7M]

(OR)

8. a) The desired frequency response of a high pass filter is [8M]

$$H_d(e^{j\omega}) = \begin{cases} 0\ , & for\ \ 0 \le |\omega| \le \dfrac{3\pi}{4} \\ e^{-j3\omega}, & for \dfrac{3\pi}{4} \le |\omega| \le \pi \end{cases}$$

Determine the filter coefficients for N=7 using Hamming window.

   b) Distinguish between FIR and IIR filters. [7M]

UNIT-V

9. a) Write a short notes on the following: [8M]
(i) Multiple access memory (ii) Multiported memory

   b) Explain the instruction set of Cortex-M processors. [7M]

(OR)

10. a) Explain the short direct addressing and circular addressing modes in programmable DSP's. [8M]

    b) Discuss the processor type in ARM Cortex-M processors. [7M]

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UNIT-I

1. a) Determine the causality and stability of following systems with impulse responses: [8M]
(i) $h(n) = 3^n u(-n)$ (ii) $h(n) = e^{2n} u(n-1)$

b) Define and explain the following discrete-time signals with necessary mathematical expressions: [7M]
(i) Periodic and Aperiodic (ii) Energy and power

(OR)

2. a) State and prove the frequency shifting property of DTFT. [7M]

b) Determine the response of the following system described by a difference equation [8M]

$$y(n) = x(n) + \frac{5}{6}y(n-1) - \frac{1}{6}y(n-2)$$

for the input $x(n) = \begin{cases} 3^n & for\ n \geq 0 \\ 0 & for\ n < 0 \end{cases}$.

UNIT-II

3. a) The $IDFT[X(k)] = x(n) = \{1, 2, 1, 0\}$, find the following by use of DFT properties: [7M]
(i) $IDFT[X(k-1)]$ (ii) $IDFT[X^2(k)]$

b) Explain the procedure to compute 8-point DFT using DIT FFT algorithm. [8M]

(OR)

4. a) Distinguish between linear convolution and circular convolution. [7M]

b) Find the 4-point IDFT of $X(k) = \{10, -2 + j2, -2, -2 - j2\}$ using DIF FFT algorithm. [8M]

UNIT-III

5. a) Find $H(z)$, for a 3rd order Butterworth digital filter using impulse invariant transformation method. Assume $T = 1$ sec. [8M]

b) Obtain the cascade and parallel form realization of IIR filter with system function [7M]

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

(OR)

6. a) Design a digital band stop Butterworth filter using bilinear transformation for the following specifications. [10M]
Lower pass band edge = 25 Hz; Lower stop band edge =100 Hz;
Upper stop band edge =150 Hz; Upper pass band edge = 225 Hz;
Stop band attenuation = 18 dB; Pass band ripple = 3 dB;
Sampling frequency = 500 Hz.

b) What is meant by canonic and non-canonic structures? Give an example. [5M]

UNIT-IV

7. a) Obtain the frequency domain characteristics of rectangular window function. [8M]

b) The desired frequency response of a low pass filter is [7M]

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & for\ -\frac{3\pi}{4} \le |\omega| \le \frac{3\pi}{4} \\ 0, & for\ \frac{3\pi}{4} \le |\omega| \le \pi \end{cases}$$

Design an FIR filter using Hamming window of length N = 7.

(OR)

8. a) List out the steps involved in design of FIR filter using frequency sampling method. [8M]

b) Sketch the direct form realization of linear phase FIR filter with [7M]

$$h(n) = \{1, 2, 3, 4, 3, 2, 1\}$$

UNIT-V

9. a) How convolution operation is performed using a single MAC unit? Explain. [8M]

b) Explain the processor architecture of Cortex-M3 processor. [7M]

(OR)

10. a) List out the on-chip peripherals in programmable DSP's and explain any two of them in detail. [8M]

b) What are the advantages of Cortex-M processor? [7M]

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Code No: R1932043 **R19** **SET - 3**

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UNIT-I

1. a) Define time invariant system. Determine the following systems are time invariant or not: [8M]
   (i) $y(n) = x(n) + nx(n+1)$ (ii) $y(n) = x(3n)$
   b) How to solve the linear constant coefficient difference equation using Z-transforms approach? Explain. [7M]

(OR)

2. a) Find the discrete time Fourier transform of a signal given by [7M]
$$x(n) = \left(\frac{1}{2}\right)^{|n-1|}$$
   b) Determine the frequency response and impulse response of the discrete-time system represented by the difference equation [8M]
$$y(n) - y(n-1) + \frac{3}{16}y(n-2) = x(n) - \frac{1}{2}x(n-1)$$

UNIT-II

3. a) State and prove the time-shifting and symmetry properties of discrete Fourier series. [8M]
   b) Find N-point DFT of a sequence [7M]
$$x(n) = Cos\left(\frac{2\pi rn}{N}\right),\ 0 \le n \le (N-1) \text{ and } 0 \le r \le (N-1)$$

(OR)

4. a) The $DFT[x(n)] = X(k) = \{4, -j2, 0, j2\}$, compute the following by use of DFT properties: [7M]
   (i) $DFT[x(n-2)]$ (ii) $DFT[x^*(n)]$
   b) Develop a radix-2 DIT FFT algorithm for evaluating 4-point DFT. Also draw its flow diagram. [8M]

UNIT-III

5. a) Design a digital Chebyshev low pass filter to satisfy the following constraints: [8M]
$$0.8 \le \left|H\left(e^{j\omega}\right)\right| \le 1, \qquad 0 \le \omega \le 0.2\pi$$
$$\left|H\left(e^{j\omega}\right)\right| \le 0.2, \quad 0.6\pi \le \omega \le \pi$$
   using impulse invariant transformation and assume $T = 1$ sec.
   b) Explain the concept of frequency transformation in analog domain with necessary mathematical expressions. [7M]

(OR)

6. a) Obtain the bilinear transformation formula for designing IIR digital filter? [8M]
   b) Draw the direct form I and direct form II structures of the system with difference equation [7M]
$$y(n) = -\frac{3}{8}y(n-1) + \frac{3}{32}y(n-2) + \frac{1}{64}y(n-3) + x(n) + 3x(n-1)$$

UNIT-IV

7. a) Design a high pass FIR filter using Hamming window with a cutoff frequency of 1.2 rad and N = 9. [8M]
   b) Obtain the ideal impulse response of a high pass FIR filter. [7M]

(OR)

8. a) Derive the necessary and sufficient condition for linear phase characteristic in FIR filter. [8M]
   b) Explain the procedure for designing of an FIR filter using frequency sampling method. [7M]

UNIT-V

9. a) Draw the block diagram of VLIW architecture and explain. [8M]
   b) Explain the memory system related to Cortex-M3 and M4 processors. [7M]

(OR)

10. a) Explain the memory mapped addressing modes and bit reversed addressing modes in programmable DSP's. [8M]
    b) Write a short note on the instruction set of Cortex-M processors. [7M]

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Code No: R1932043 **R19** **SET - 4**

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UNIT-I

1. a) What is meant by BIBO stable system? Derive its necessary and sufficient condition. [7M]

   b) Solve the following difference equation using Z-transform [8M]
   $$y(n) + 2y(n-1) = x(n)$$
   with $x(n) = (1/3)^n u(n)$ and the initial condition $y(-1) = 1$.

(OR)

2. a) Check whether the following systems are linear or not. [8M]
   (i) $y(n) = |x(n)|$ (ii) $y(n) = \sum_{k=0}^{N-1} x(n-k)$

   b) A unit sample response of a discrete time system is given by [7M]
   $$h(n) = \frac{1}{2}\delta(n) + \delta(n-1) + \frac{1}{2}\delta(n-2)$$
   Determine the frequency response of a system and also sketch its magnitude and phase spectra.

UNIT-II

3. a) Determine and sketch the magnitude and phase spectra of the periodic signal, $x(n) = \{1, 1, 0, 0\}$ with period N = 4. [8M]

   b) State and prove the periodicity and circular time shifting properties of DFT. [7M]

(OR)

4. a) Find the circular convolution of given two sequences using DFT and IDFT. $x_1(n) = \{1, 2, 3, 4\}$ and $x_2(n) = \{1, 1, 2, 2\}$. [8M]

   b) What is the importance of FFT? Explain with an example. [7M]

UNIT-III

5. a) Design a digital Chebyshev low pass filter using bilinear transformation with the following specifications: [8M]
   3 dB ripple in the pass band $0 \leq \omega \leq 0.2\pi$;
   25 dB attenuation in the stop band $0.45\pi \leq \omega \leq \pi$;
   Assume $T = 1$ sec.

   b) Explain the transposed form structures with an example. [7M]

(OR)

6. a) Distinguish between Butterworth and Chebyshev filters. [7M]

   b) What are the advantages of parallel form realization? Implement the IIR filter with difference equation [8M]

$$y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.7x(n) - 0.252x(n-2)$$

   in parallel form.

UNIT-IV

7. a) Design an FIR digital filter to approximate an ideal low pass filter with pass band gain of unity, cut-off frequency of 850 Hz and sampling frequency of 5000 Hz. The length of impulse response should be 5. Use rectangular window. [8M]

   b) Obtain the direct form realization of linear phase FIR filter with system function [7M]

$$H(z) = \frac{1}{2} + \frac{1}{3}z^{-1} + z^{-2} + \frac{1}{4}z^{-3} + z^{-4} + \frac{1}{3}z^{-5} + \frac{1}{2}z^{-6}$$

(OR)

8. a) Explain the frequency domain characteristics of various window functions used in FIR filter design. [7M]

   b) The desired frequency response of a low pass filter is [8M]

$$H_d(e^{j\omega}) = \begin{cases} e^{-j8\omega}, & for \;\; 0 \le |\omega| \le \frac{\pi}{2} \\ 0, & for \;\; \frac{\pi}{2} \le |\omega| \le \pi \end{cases}$$

   Design an FIR filter with N = 17 using frequency sampling method.

UNIT-V

9. a) What is meant by instruction pipelining? Explain with an example. [8M]

   b) Explain the differences between Von Neumann and Harvard architectures. Which architecture is preferred for DSP applications? [7M]

(OR)

10. Draw the block diagram of Cotex-M3 and Cortex-M4 processor? Explain. [15M]

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