

III B.Tech II Semester Regular Examinations, Apr/May 2008
DIGITAL SIGNAL PROCESSING
 (Common to Electrical & Electronic Engineering, Electronics &
 Communication Engineering, Electronics & Instrumentation Engineering,
 Electronics & Control Engineering, Electronics & Telematics and
 Instrumentation & Control Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

1. (a) State and prove the basic properties of discrete time systems?
 (b) A discrete time LTI system has impulse response $h(n) = \{1, 3, 2, -1, 1\}$ for $-1 \leq n \leq 3$. Using linearity and time invariance property, determine the system output $y(n)$ if the input $x(n)$ is given by $x(n) = 2\delta(n) - \delta(n-1)$. [16]
2. (a) Define DFT of a sequence $x(n)$. Obtain the relationship between DFT and DTFT.
 (b) Consider a sequence $x(n) = \{2, -1, 1, 1\}$ and $T = 0.5$ compute its DFT and compare it with its DTFT. [8+8]
3. An 8 point sequence is given by $x(n) = \{2, 2, 2, 2, 1, 1, 1, 1\}$. Compute 8 point DFT of $x(n)$ by
 (a) radix - 2 D I T F F T
 (b) radix - 2 D I F F T
 Also sketch magnitude and phase spectrum. [16]
4. (a) 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.
 (b) Define stable and unstable system. Test the condition for stability of the first-order IIR filter governed by the equation $y(n) = x(n) + bx(n-1)$. [8+8]
5. (a) Explain difference between frequency responses of analog LPF and digital LPF.
 (b) Convert the analog transfer function $H(s) = 1/(s+1)(s+2)$
 Find $H(Z)$ using Impulse Invariant method, also check stability of this filter. Assume $T = 1\text{sec}$. [6+10]
6. (a) Describe the FIR filter characteristics in time domain.
 (b) Determine the frequency response of a linear phase FIR filter given by $y(n) = A_1x(n) + A_2x(n-1) + A_3x(n-2) + A_2x(n-3) + A_1x(n-4)$. [6+10]
7. Consider the signal $x(n) = n u(n)$

- (a) Determine the spectrum of a signal.
 - (b) The signal is applied to a decimator that reduces sampling rate by a factor by '3'. Determine its output spectrum.
 - (c) Show that the spectrum in part (ii) is simply Fourier transform of $x(3n)$. [16]
8. (a) What are the advantages of DSP processors over conventional microprocessors?
- (b) Explain the Implementation of convolver with single multiplier/adder. [8+8]

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1. (a) Find the inverse DTFT of

$$X(e^{j\omega}) = \frac{1}{1 - \frac{1}{3}e^{j10\omega}}$$

 (b) Find a difference equation to implement a filter that has a unit sample response

$$h(n) = \left(\frac{1}{4}\right)^n \cos\left(\frac{\pi n}{3}\right) u(n). \quad [16]$$
2. (a) Define DFT of a sequence. Compute the N - point DFT of the sequence.

$$X(n) = \cos(2\pi rn/N), 0 \leq n \leq N-1 \text{ and } 0 \leq r \leq N-1$$

 (b) Explain how DFT can be obtained by sampling DFS for a given sequence. [8+8]
3. (a) Explain the inverse FFT algorithm to compute inverse DFT of a N=8. Draw the flow graph for the same.

 (b) Compute the FFT for the sequence { 1, 0, 0, 0, 0, 0, 0, 0 } [8+8]
4. (a) Determine the frequency response, magnitude response and phase response for the system given by $y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) - x(n-1)$

 (b) A causal LTI system is described by the difference equation $y(n) = y(n-1) + y(n-2) + x(n-1)$, where $x(n)$ is the input and $y(n)$ is the output. Find
 - i. The system function $H(Z) = Y(Z)/X(Z)$ for the system, plot the poles and zeroes of $H(Z)$ and indicate the region of convergence.
 - ii. The unit sample response of the system.
 - iii. Is this system stable or not? [6+10]
5. (a) Describe digital IIR filter characterization in Z ? domain.

 (b) Find $H(Z)$ using Impulse Invariant method for given analog system.

$$H(s) = 1/(s + 0.5) (s^2 + 0.5s + 2) \quad [6+10]$$
6. (a) Describe the FIR filter characteristics in time domain.

 (b) Determine the frequency response of a linear phase FIR filter given by

$$y(n) = A_1x(n) + A_2x(n-1) + A_3x(n-2) + A_2x(n-3) + A_1x(n-4). \quad [6+10]$$
7. With the help of block diagram explain the sampling rate conversion by a rational factor 'I/D'. Obtain necessary expressions. [16]

8. Discuss various interrupt types supported by TMS320C5X processor. [16]

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1. (a) Find the convolution of the given two signals:
 graphically: $x(n)=u(n)-u(n-5)$
 $h(n)=2[u(n)-u(n-3)]$
 (b) Verify the result of part(a) by evaluating directly the convolution sum. [16]
2. (a) Compute Discrete Fourier transform of the following finite length sequence considered to be of length N.
 i. $x(n) = \delta(n + n_0)$ where $0 < n_0 < N$
 ii. $x(n) = a^n$ where $0 < a < 1$.
 (b) If $x(n)$ denotes a finite length sequence of length N, show that $x((-n))_N = x((N - n))_N$. [8+8]
3. (a) Implement the decimation in time FFT algorithm for N=16.
 (b) In the above Question how many non - trivial multiplications are required. [10+6]
4. (a) Determine the frequency response , magnitude response and phase response for the system given by $y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) - x(n-1)$
 (b) A causal LTI system is described by the difference equation $y(n)=y(n-1)+y(n-2)+x(n-1)$, where $x(n)$ is the input and $y(n)$ is the output. Find
 i. The system function $H(Z)=Y(Z)/X(Z)$ for the system, plot the poles and zeroes of $H(Z)$ and indicate the region of convergence.
 ii. The unit sample response of the system.
 iii. Is this system stable or not? [6+10]
5. Convert analog filter with transfer function
 $(s + 0.1) / (s + 0.1)^2 + 9$
 Into digital IIR filter using Impulse Invariant method. Also sketch response and comment on 'T' value how it affects aliasing. [16]
6. Design high pass linear phase filter with frequency response

$$H_d(e^{j\omega}) = e^{-j2\omega n_0} \quad \omega_c \leq |\omega| \leq \pi$$

$$= 0 \quad \text{otherwise}$$

For $N=7$ and $\omega_c = \pi/4$ use

- (a) Rectungular window
 - (b) Hamming Window. [16]
7. (a) Consider a signal $x(n) = u(n)$
- i. Obtain a signal with a decimation factor '3'
 - ii. Obtain a signal with a interpolation factor '3'.
- (b) Consider a signal $x(n) = \text{Sin}\pi n. u(n)$
- i. Obtain a signal with a decimation factor '2'
 - ii. Obtain a signal with a interpolation factor '2'. [6+10]
8. (a) What are the advantages of DSP processors over conventional microproces-
sors?
- (b) Explain the Implementation of convolver with single multiplier/adder. [8+8]

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1. (a) Define the following terms as referred to LTI discrete time system:
 - i. Stability
 - ii. Causality
 - iii. Time invariance
 - iv. Linearity.
- (b) Determine whether the following system is
 - i. Linear
 - ii. Causal
 - iii. Stable
 - iv. Time invariant
$$y(n) = \log_{10} |x(n)|$$

Justify your answer. [16]
2. (a) Define DFT of a sequence $x(n)$. Obtain the relationship between DFT and DTFT.
- (b) Consider a sequence $x(n) = \{2, -1, 1, 1\}$ and $T = 0.5$ compute its DFT and compare it with its DTFT. [8+8]
3. (a) Implement the decimation in time FFT algorithm for $N=16$.
- (b) In the above Question how many non - trivial multiplications are required. [10+6]
4. (a) Explain how the analysis of discrete time invariant system can be obtained using convolution properties of Z transform.
- (b) Determine the impulse response of the system described by the difference equation $y(n)-3y(n-1)-4y(n-2)=x(n)+2x(n-1)$ using Z transform. [8+8]
5. (a) Describe digital IIR filter characterization in Z ? domain.
- (b) Find $H(Z)$ using Impulse Invariant method for given analog system.
 $H(s) = 1/(s + 0.5) (s^2 + 0.5s + 2)$ [6+10]
6. (a) Describe the FIR filter characteristics in time domain.

- (b) Determine the frequency response of a linear phase FIR filter given by
 $y(n) = A_1x(n) + A_2x(n-1) + A_3x(n-2) + A_2x(n-3) + A_1x(n-4)$. [6+10]
7. (a) Discuss the applications of Multirate Digital Signal Processing.
(b) Describe the decimation process with a factor of ' M '. Obtain necessary expression. [8+8]
8. (a) What are the advantages of CISC?
(b) What are the advantages of RISC? [16]
