SYED AMMAL ENGINEERING COLLEGE

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Department of EEE

Question bank

Course Code and Name : EE 6403 Discrete Time systems and Signal Processing
Year and Semester : II year IV Semester
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UNIT-I – INTRODUCTION
PART A (2 marks)

1. Define Signal.
2. Define system.
3. What are the steps involved in digital signal processing?
4. Give some applications of DSP?
5. Write the classifications of DT Signals.
6. What is an Energy and Power signal?
7. What is Discrete Time Systems?
8. Write the Various classifications of Discrete-Time systems.
9. Define linear system
10. Define Static & Dynamic systems
11. Define causal and non causal signals.
12. Define odd and even signal
13. Define deterministic and random signal
14. Define periodic and Aperiodic signals.
15. Define causal and non causal systems
16. Define stable and unstable system
17. Define time variant and time invariant system
18. Define recursive and non recursive system
19. Define IIR & FIR systems
20. Why linear convolution is important in DSP?
21. What is zero padding?
22. List the difference between Linear and Circular Convolution
23. What are the types of convolutions?
24. Define sampling theorem
25. Define Aliasing
26. What is sampling?
27. What is quantization?
28. What are the standard discrete time signals?
29. Define impulse and unit step signal.
30. What are the mathematical operations performed over discrete time signals?

31. Given a continuous time signal x(t)=2cos500πt. What is the Nyquist rate and fundamental frequency of the signal?
32. Consider the analog signal x(t)=3 cos 50πt + 10 sin 300 πt - cos 100 πt. What is the Nyquist rate for this signal.
33. Test whether the system governed by the relation is linear time invariant or not?

$$y[n] = \sum_{k=-\infty}^{n} x[k]$$

34. Determine the fundamental period of the signal

$$x[n] = \cos\left(\frac{30\pi n}{1o5}\right)$$

35. Check whether the signal defined by x[n] = [5 $(1/2)^n$ + 4 $(1/3)^n$] u(n) is causal.

PART B & PART C

1. What is meant by energy and power signal? Determine whether the following signals are energy or power or neither energy nor power signals. (12)
   - $x_1[n] = \left(\frac{1}{2}\right)^n u[n]$
   - $x_2[n] = sin\left(\frac{\pi n}{6}\right)$
   - $x_3[n] = e^{\left(j\frac{\pi n}{3}+\frac{\pi}{6}\right)}$
   - $x_4[n] = e^{2n}u[n]$
2. Explain the concept of quantization (4)
3. Check for following systems are linear, causal, time invariant, stable, static (16)
   - $y[n] = x\left(\frac{1}{2n}\right)$
   - $y[n] = \sin\left(x[n]\right)$
4. Check whether the following are periodic (8)
   - $x[n] = \cos\left(3\pi n\right)$
   - $x[n] = \sin\left(3n\right)$
5. Check whether the following are energy or power signals. (8)
   - $x_1[n] = \left(\frac{1}{2}\right)^n u[n]$
   - $x_3[n] = Ae^{(j\omega n)}$
6. What do you mean by Nyquist rate? Give its significance. (6)
7. Explain the classification of discrete signal. (10)
8. Explain the classification of discrete systems. (8)
9. Explain neatly about the standard signals available (8)
10. Explain neatly about the operations performed on a signal (8)

11. Determine whether the system is linear, time invariant, memory less and causal.
$$y[n] = x[n^2]$$ (8)
12. Determine whether the following is an energy signal or power signal (8)
$$(1)\ x_1(n) = 6\cos\left[\frac{\pi}{2}n\right]$$
$$(2)\ x_2(n) = 3[0.5]^n u(n)$$
13. Starting from first principles, state and explain sampling theorem both in time domain and in frequency domain. (16)
14. Determine the response of the following systems to the input signal (16)
$$x(n) = \begin{cases} |n|, & -3 \le n \le 3 \\ 0, & \text{otherwise} \end{cases}$$
(i) $x_1(n)=x(n-2)\delta(n-3)$
(ii) $x_2(n)=x(n+1)u(n-1)$
(iii) $y(n) = \frac{1}{3}[x(n+1) + x(n) + x(n-1)]$
(iv) $y(n)=\max[x(n+1), x(n), x(n-1)]$
(v) Find the even and odd components of given x(n).
15. A discrete time systems can be
   - Static or dynamic
   - Linear or non Linear
   - Time invariant or time varying
   - Stable or unstable

   Examine the following systems with respect to the properties above
   - $y(n)=x(n)+nx(n+1)$.
   - $y(n)=x(n)\cos(x(n))$

16. Check the causality and stability of the systems $y(n)=x(-n)+x(n-2)+x(2n-1)$. (8)
17. Check the system for linearity and time invariance $y(n)=(n-1)x^2(n)+c$. (8)
18. Explain the digital signal processing system with necessary sketches and give its merits and demerits. (16)

UNIT-II DISCRETE TIME SYSTEM ANALYSIS
PART A(2 marks)

1. Define Z transform.
2. What are the basic elements used to construct the block diagram of discrete time system?
3. What is ROC in Z-Transform?

4. List any four properties of Z-Transform.
5. What are the different methods of evaluating inverse z-transform?
6. What are the properties of convolution?
7. Define DTFT.
8. State the condition for existence of DTFT?
9. List the properties of DTFT.
10. What is the DTFT of unit sample?
11. Define Zero padding.
12. Define step and impulse response of a discrete time system.
13. Define convolution sum or discrete convolution or linear convolution.
14. State parseval's theorem.
15. Find Z transform of x(n)={1,2,3,4}
16. State frequency response of discrete time system

PART B & PART C

1. Find the Z transform and its ROC of (6)

$$x(n) = \left[\frac{-1}{5}\right]^n u(n) + 5\left[\frac{1}{2}\right]^{-n} u(-n-1)$$

2. A system is described by the difference equation given below

$$y(n) - \left[\frac{1}{2}\right] y(n-1) = 5x(n).$$

Determine the solution, when the input is

$$x(n) = \left[\frac{1}{5}\right]^n u(n)$$

and the initial condition is given by y(-1)=1, using z transform. (10)

3. Determine the impulse response of the system described by the difference equation using Z transform and discuss its stability. (10)

$$y(n) = y(n-1) - \left[\frac{1}{2}\right] y(n-2) + x(n) + x(n-1)$$

4. Find the linear convolution of x(n)={2,4,6,8,10} with h(n)={1,3,5,7,9} (6)

5. Determine the Z transform of
   (1) $x(n)=a^n \cos\omega_0 n \, u(n)$ (5)
   (2) $x(n)=3^n u(n)$ (3)

6. Obtain x(n) for the following (8)

$$X(z) = \frac{1}{1-1.5z^{-1}+0.5z^{-2}} \text{ for ROC } ;|z|>1,\ |z|<0.5,\ 05<|z|<1$$

7. Explain the properties of Z-transform. (8)
8. Find the impulse response given by difference equation.
   y(n)-3y(n-1)-4y(n-2)=x(n)+2x(n -1) (8)

9. Test the stability of given systems. (8)
   - y(n)=cos(x(n))
   - y(n)=x(-n-2)
   - y(n)=n x(n)

10. Find the convolution. (8)

$$x(n)=\{-1,\underset{\uparrow}{1},2,-2\},\quad h(n)=\{0.5,1,-1,\underset{\uparrow}{2},0.75\}$$

11. Obtain the discrete Fourier series coefficients of x(n)=cosw0n . (4)
12. Determine x(n) for the given X(Z)with ROC (12)
    - |z|>2
    - |z| <2

$$X(z) = \frac{1+3z^{-1}}{1+3z^{-1}+2z^{-2}}$$

13. Evaluate the frequency response of the system described by system function (8)

$$H(z) = \frac{1}{1-0.5z^{-1}}$$

14. Determine the causal signal x(n) whose z-transform is given by (10)

$$X(z) = \frac{1}{1-z^{-1}+0.5z^{-2}}$$

15. Determine the z-transform of the signal x(n)=(cosw0n)u(n). (6)
16. Find the z-transform and ROC of (8)

$$x[n] = r^n \cos(n\theta)\, u[n]$$

17. Find Inverse z-transform of (8)

$$X(Z) = \frac{z}{(3z^2-4z+1)}$$

ROC |z|>1

18. Determine the DTFT of the given sequence $x[n]=a^n (u(n)-u(n-8))$, $|a|<1$. (8)
19. Prove the linearity and frequency shifting theorems of the DTFT. (8)
20. Explain neatly with proof the properties of DTFT (10)

UNIT III Discrete Fourier transform and computation

PART A(2 marks)

1. What is DFT?
2. Define N point DFT.
3. What is DFT of unit impulse $\delta(n)$?.
4. List the properties of DFT.
5. State Linearity property of DFT.
6. Why the result of circular and linear convolution is not same?
7. What is the disadvantage of direct computation of DFT?
8. What is the way to reduce number of arithmetic operations during DFT computation?
9. What is the computational complexity using FFT algorithm?
10. How linear filtering is done using FFT?
11. What is zero padding? What are its uses?
12. Calculate the number of multiplications needed in the calculation of DFT using FFT algorithm with using FFT algorithm with 32-point sequence.
13. What is FFT?
14. What is a decimation-in-time algorithm?
15. What are the differences and similarities between DIF and DIT algorithms?
16. What are the applications of FFT algorithms?
17. What is a decimation-in-frequency algorithm?

PART B & PART C

1. State and prove convolution property of DFT. (6)
2. Find the inverse DFT of (10)
$$X(K) = \{7,\ -\sqrt{2}-j\sqrt{2},\ -j,\ \sqrt{2}-j\sqrt{2},\ 1,\ \sqrt{2}+j\sqrt{2},\ j,\ -\sqrt{2}+j\sqrt{2}\}$$
3. Derive the decimation-in time radix-2 FFT algorithm and draw signal flow graph for 8-point sequence. (8)
4. Using FFT algorithm, compute the DFT of x(n)={2,2,2,2,1,1,1,1}. (8)
5. Explain the following properties of DFT.
   - Convolution.
   - Time shifting
   - Conjugate Symmetry. (10)
6. Compute the 4 point DFT of x(n) ={0,1, 2,3}. (6)
7. Explain the Radix 2 DIF - FFT algorithm for 8 point DFT. (8)
8. Obtain the 8 point DFT using DIT - FFT algorithm for x[n]={1,1,1,1,1,1,1,1} (8)

9. 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 radix DIT-FFT method also sketch the magnitude and phase. (16)

10. Determine the response of LTI system when the input sequence is x(n)={-1,1,2,1,-1} using radix 2 DIF FFT. The impulse response is h(n)={-1,1,-1,1}. (16)

11. Describe the following properties of DFT.
    - Time reversal
    - Circular convolution. (10)
12. Obtain the circular convolution of
    $x_1(n)$= {1, 2, 2, 1}
    $x_2(n)$ ={1, 2, 3, 1} (6)

13. Find the output y[n] of a filter whose impulse response is h[n]={1,1,1} and input signal x[n]={3,-1,0,1,3,2,0,1,2,1} using overlap save method. (16)

14. The first five points of the eight point DFT of a real valued sequence are {0.25, 0.125 – j0.3018, 0 , 0.125 - j0.0518 , 0 }. Determine the remaining three points. (4)
15. Compute the eight point DFT of the sequence x=[1,1,1,1,1,1,1,1], using Decimation-in-Frequency FFT algorithm. (12)

16. Determine 8 point DFT of the sequence x(n)={1,1,1,1,1,1,0,0,0}. (12)
17. Find circular convolution of the sequence using concentric circle method x_1={1,1,2,1} and x_2={1,2,3,4} (4)

UNIT-IV - DESIGN OF DEGITAL FILTER

PART A(2 marks)

1. Define IIR filter?
2. What are the various methods to design IIR filters?
3. Which of the methods do you prefer for designing IIR filters? Why?
4. What is the main problem of bilinear transformation?
5. What is prewarping?
6. State the frequency relationship in bilinear transformation?
7. Where the $j\omega$ axis of s-plane is mapped in z-plane in bilinear transformation?
8. Where left hand side and right hand side are mapped in z-plane in bilinear transformation?
9. What is the frequency response of Butterworth filter?
10. Which filter approximation has ripples in its response?
11. Can IIR filter be designed without analog filters?

12. What is the advantage of designing IIR Filters using pole-zero plots?
13. Compare the digital and analog filter.
14. What are the advantages and disadvantages of digital filters?
15. What is impulse invariant transformation?
16. How analog poles are mapped to digital poles in impulse invariant transformation?
17. What is the importance of poles in filter design?
18. Why an impulse invariant transformation is not considered to be one-to one?
19. What is bilinear transformation?
20. How the order of the filter affects the frequency response of Butterworth filter?
21. Write the properties of Chebyshev type –1 filters.
22. Compare the Butterworth and Chebyshev Type-1 filters.
23. What is FIR filters?
24. What are the different types of filters based on impulse response?
25. What are the different types of filter based on frequency response?
26. What are the techniques of designing FIR filters?
27. State the condition for a digital filter to be causal and stable.
28. What is the reason that FIR filter is always stable?
29. What are the properties of FIR filter?
30. How phase distortion and delay distortions are introduced?
31. Write the steps involved in FIR filter design.
32. What are the advantages of FIR filters?
33. What are the disadvantages of FIR filters?
34. What is the necessary and sufficient condition for the linear phase characteristic of an FIR filter?
35. What are the conditions to be satisfied for constant phase delay in linear phase FIR filters?
36. How constant group delay & phase delay is achieved in linear phase FIR filters?
37. What are the possible types of impulse response for linear phase FIR filters?
38. List the well-known design techniques of linear phase FIR filters.
39. What is Gibb's phenomenon (or Gibb's Oscillation)?
40. What are the desirable characteristics of the frequency response of window function?
41. Write the procedure for designing FIR filter using frequency-sampling method.
42. What are the drawback in FIR filter design using windows and frequency sampling method? How it is overcome?
43. List the characteristics of FIR filters designed using windows.
44. What is the mathematical problem involved in the design of window function?
45. List the desirable features of Kaiser Window spectrum.

PART B & PART C

1. Obtain cascade and parallel realization for the system having difference equation
   $y(n)+0.1y(n-1)-0.2y(n-2)=3x(n)+3.6x(n-1)+0.6x(n-2)$ (8)

2. Design a length-5 FIR band reject filter with a lower cut-off frequency of 2KHz, an upper cut-off frequency of 2.4 KHz, and a sampling rate of 8000Hz using Hamming window. (8)

3. Explain impulse invariant method of designing IIR filter. (6)
4. Design a second order digital low pass Butterworth filter with a cut-off frequency 3.4KHz at a sampling rate of 8 KHz using bilinear transformation. (10)
5. Design an FIR linear phase, digital filter approximating the ideal frequency response (12)

$$H_d(w) = \begin{cases} 1, & |w| \leq \frac{\pi}{6} \\ 0, & \frac{\pi}{6} < |w| \leq \pi \end{cases}$$

6. Determine the coefficients of a 25 tap filter based on the window method with a rectangular window. (16)

7. Convert the analog filter with system function into a digital IIR filter by means of the impulse invariance method. (8)

$$G(s) = \frac{(s+0.1)}{(s+0.1)^2 + 9}$$

8. Realize the following with minimum number of multipliers and direct form (8)

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

9. Design a butterworth filter using impulse invariance method for the following specifications (12)

$$\begin{cases} 0.8 \leq |H(e^{j\omega})| \leq 1 \ ; & 0 \leq \omega \leq 0.2\pi \\ |H(e^{j\omega})| \leq 0.2 \ ; & 0.6\pi \leq \omega \leq \pi \end{cases}$$

10. Design a filter with desired frequency response (16)

$$\begin{cases} e^{-j3\omega} \ ; & \frac{-3\pi}{4} \leq \omega \leq \frac{3\pi}{4} \\ 0 \ ; & otherwise \end{cases}$$

Using Hanning window for N=7

11. For the analog transfer function

$$H(s) = \frac{2}{(s+1)(s+3)}$$

Determine H(z) using bilinear transformation with T=0.1 sec.

12. Realize the following using cascade and parallel form (12)

$$H(z) = \frac{3 + 3.6z^{-1} + 0.6z^{-2}}{1 + 0.1z^{-1} - 0.2z^{-2}}$$

13. Explain how an analog filter maps into a digital filter in Impulse Invariant transformation (4)

UNIT V - DIGITAL SIGNAL PROCESSOR

PART A(2 marks)

1. What are the classifications of Digital Signal Processors?
2. What are the factors that influence selection of DSPs?
3. Write short notes on general purpose DSP processors
4. List the types of special purpose DSP processors.
5. Briefly explain about Harvard architecture.
6. Draw the Von Newmann Architecture.
7. Draw the Harvard architecture.
8. Draw the VLIW architecture
9. What are the types of MAC is available?
10. What are four phases available in pipeline technique?
11. What is pipelining depth?
12. Write down the name of the addressing modes.
13. What are the instructions used for block transfer in C5X Processors?
14. Briefly explain about the dedicated register addressing modes.
15. Briefly explain about bit-reversed addressing mode?
16. Briefly explain about circular addressing mode.
17. Write the name of various part of C5X hardware.
18. Write short notes about arithmetic logic unit and accumulator.
19. Write short notes about parallel logic unit.
20. What is meant by auxiliary register file?
21. Write short notes about circular registers in C5X.
22. What are the factors that influence selection of DSPs?
23. What are the applications of PDSPs?
24. Give some examples for fixed point DSPs.
25. Give some example for floating point DSPs?
26. What is pipelining?
27. What are the advantages of VLIW architecture?
28. What are the disadvantages of VLIW architecture?
29. What is the pipeline depth of TMS320C50 and TMS320C54x?
30. What are the different buses of TMS320C5x?
31. Give the functions of program bus?
32. Give the functions of program address bus?

33. Give the functions of data read bus?
34. Give the functions of data read address bus?
35. What are the different stages in pipelining?
36. List the various registers used with ARAU.
37. What are the elements that the control processing unit of ‘C5x consists of ?
38. What is the function of parallel logic unit?
39. List the on chip peripherals in ‘C5x.
40. What are the arithmetic instructions of ‘C5x?
41. What are the shift instructions?
42. What are the general purpose I/O pins?
43. What are the logical instructions of ‘C5x?
44. What are load/store instructions?
45. Mention the addressing modes available in TMS320C5X processor?
46. What is function of NOP instruction?
47. What is function of ZAC instruction?
48. Give the function of BIT instruction.
49. What is use of ADD instruction?
50. Give the advantages of DSPs?

PART B & PART C

1. Draw the block diagram of Harvard architecture and explain. (8)
2. Explain the advantages and disadvantages of VLIW architecture. (8)
3. Write short notes on
    - Memory mapped register addressing
    - Circular addressing mode
    - Auxiliary registers (6+6+4)
4. Explain various addressing modes of a digital signal processor. (16)
5. Draw the functional block diagram of a digital signal processor and explain. (16)
6. Explain Von Neumann, Harvard architecture and modified Harvard architecture for the computer. (16)
7. Explain how convolution is performed using a single MAC unit. (8)
8. What is MAC unit? Explain its functions. (8)
9. Explain about pipelining in DSP. (8)
10. Discuss the addressing modes used in programmable DSP’s (8)
11. Explain the architecture of TMS320C50 with a neat diagram. (16)
12. Describe the Architectural details and features of a DSP processor. (16)