



**SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:: PUTTUR  
(AUTONOMOUS)**

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**Subject:** DIGITAL SIGNAL PROCESSING (23EC0419)

**Course & Branch:** B.Tech – ECE

**Year & Sem:** III-B.Tech. & II-Sem.

**Regulation:** R23

**UNIT –I  
INTRODUCTION TO DISCRETE TIME SIGNALS AND SYSTEMS**

- |    |   |           |       |
|----|---|-----------|-------|
| 1  | a) Sketch the discrete time signal is $x(n)= u(n-2)$  | [L1][CO1] | [2M]  |
|    | b) Define Discrete time LTI system  | [L1][CO1] | [2M]  |
|    | c) Define Z-transform   | [L1][CO1] | [2M]  |
|    | d) What is BIBO stability?  | [L1][CO1] | [2M]  |
|    | e) What is meant by inverse Z-transform?  | [L1][CO1] | [2M]  |
| 2  | a) Explain about the block diagram of digital signal processing   | [L2][CO1] | [6M]  |
|    | b) Write the advantages and applications of DSP   | [L1][CO1] | [4M]  |
| 3  | a) Discuss the various classifications of Discrete time signals with examples   | [L2][CO1] | [5M]  |
|    | b) What are the types of representation of discrete-time signals? Represent a sequence in all types.                      | [L1][CO1] | [5M]  |
| 4  | What are the basic operations on discrete-time signals? Illustrate with an example.                                       | [L3][CO1] | [10M] |
| 5  | a) Describe the classifications of Discrete Time systems with examples  | [L2][CO1] | [6M]  |
|    | b) Explain the frequency-domain representation of discrete-time signals and systems.                                      | [L3][CO1] | [4M]  |
| 6  | a) Find the energy and power for the given signal is $(1/2)^n u(n)$   | [L2][CO1] | [5M]  |
|    | b) Define ROC and describe any five properties of ROC   | [L3][CO1] | [5M]  |
| 7  | a) Explain any three properties of Z-Transform.   | [L2][CO1] | [6M]  |
|    | b) With a neat z-plane diagram, explain the concept of poles and zeros of a system.                                       | [L2][CO1] | [4M]  |
| 8  | a) Determine the transfer function of a DTS described by the difference equation $y(n)=1/3 y(n-1)-1/5 y(n-2)+x(n)-x(n-2)$ | [L3][CO1] | [4M]  |
|    | b) Find the system Response for unit impulse, step and ramp signals using Z-transform                                     | [L3][CO1] | [6M]  |
| 9  | Solve the difference equation $y(n)+2y(n-1)=x(n)$ with input $x(n)=(1/3)^n u(n)$ and the initial condition $y(-1)=1$      | [L3][CO1] | [10M] |
| 10 | A discrete-time LTI system is described by the difference equation is $y(n)-0.7 y(n-1)+0.12 y(n-2)= x(n)+0.5x(n-1)$ .     | [L3][CO1] | [10M] |
|    | a) Obtain the transfer function $H(z)$ ,  |           |       |
|    | b) Find the poles and zeros of the system.  |           |       |
|    | c) Comment on the stability of the system.  |           |       |
| 11 | Find the inverse Z- transform of $X(Z)=z^{-1}/3-4z^{-1}+z^{-2}$ ; $ROC z  > 1$  | [L3][CO1] | [10M] |

**UNIT-II**  
**DISCRETE FOURIER TRANSFORM**

<b>1</b>	<b>a)</b> Define Discrete Fourier series	[L1][CO2]	[2M]
	<b>b)</b> What is DFT? Give its significance with necessary equations.	[L1][CO2]	[2M]
	<b>c)</b> What is FFT	[L1][CO3]	[2M]
	<b>d)</b> Define Inverse FFT	[L1][CO3]	[2M]
	<b>e)</b> Compare the Radix-2 DIT and DIF FFTs.	[L1][CO3]	[2M]
<b>2</b>	State and Prove any four properties of DFS	[L3][CO2]	[10M]
<b>3</b>	State and prove the following properties of DFT i) Linearity ii) Time shifting iii) Time scaling iv) Time reversing	[L3][CO2]	[10M]
<b>4</b>	Determine the 8point DFT of the sequence $x(n) = \{1,1,1,1,1,1,1,0\}$ .	[L3][CO2]	[10M]
<b>5</b>	<b>a)</b> Find the IDFT of the sequence $X(K) = \{1,0,1,0\}$ .	[L3][CO2]	[6M]
	<b>b)</b> Explain the difference between linear convolution and circular convolution.	[L2][CO2]	[4M]
<b>6</b>	Find the linear convolution of the sequences $x(n)$ and $h(n)$ using DFT. $x(n)=\{1,0,2\}$ , $h(n)=\{1,1\}$	[L3][CO2]	[10M]
<b>7</b>	<b>a)</b> State the sampling theorem and its significance in DSP.	[L1][CO2]	[5M]
	<b>b)</b> Explain the process of quantization and its effects on a signal.	[L2][CO2]	[5M]
<b>8</b>	Explain about the Decimation in Time FFT algorithm with necessary diagram.	[L2][CO3]	[10M]
<b>9</b>	Compute 8-point DFT of the sequence $x(n) = \{1,2,3,4,4,3,2,1\}$ using Radix-2 DIT-FFT Algorithm.	[L3][CO3]	[10M]
<b>10</b>	Compute DFT of the sequence $x(n) = \{1,1,1,1,1,1,1,0\}$ using Radix-2 DIT FFT algorithm.	[L3][CO3]	[10M]
<b>11</b>	Compute 8-point DFT of the sequence $x(n) = \{0,1,2,3,4,5,6,7\}$ using Radix-2 DIF-FFT Algorithm.	[L3][CO3]	[10M]

## UNIT-III

### IIR FILTERS

- |    |   |           |       |
|----|---|-----------|-------|
| 1  | <p>a) What are the basic types of filters and on what basis are they classified?</p> <p>b) List the filter types in designing the IIR filters?</p> <p>c) Compare impulse invariant and bilinear transformation.</p> <p>d) List the different types of structures for realization of IIR systems.</p> <p>e) Compare direct form-I and direct form-II</p>   | [L1][CO4] | [2M]  |
|    |   | [L2][CO4] | [2M]  |
| 2  | Design an analog Butterworth filter that has 20dB passband attenuation at a Frequency of 20rad/sec and at least 10dB stop band attenuation at 30 rad/sec.   | [L3][CO4] | [10M] |
| 3  | <p>a) Explain the steps in the design of an analog Chebyshev lowpass filter.</p> <p>b) Design an analog filter using Chebyshev approximation for the specifications<br/> <math>\alpha_p=3dB</math> and <math>\alpha_s=16dB</math>; <math>f_p=1KHz</math> and <math>f_s=2KHz</math>.</p>   | [L2][CO4] | [5M]  |
|    |   | [L3][CO4] | [5M]  |
| 4  | Illustrate the conversion steps in Impulse Invariance & Bilinear transformation method?   | [L3][CO4] | [10M] |
| 5  | <p>a) For the analog transfer function</p> $H(S) = \frac{2}{(S+1)(S+3)}$ <p>Determine <math>H(Z)</math> using Impulse Invariance method. Assume <math>T=1</math> Sec.</p> <p>b) Apply Bilinear transformation to</p> $H(S) = \frac{4}{(S+3)(S+4)}$ <p>with <math>T=0.5</math> Sec and find <math>H(Z)</math>.</p>   | [L3][CO4] | [5M]  |
| 6  | <p>Design a digital Butterworth IIR filter satisfying the following constraints. Let <math>T=1</math> s, apply Impulse Invariant Transformation.</p> $0.8 \leq  H(w)  \leq 1 \quad ; 0 \leq w \leq 0.2\pi$ $ H(w)  \leq 0.2 \quad ; 0.32\pi \leq w \leq \pi$  | [L3][CO4] | [10M] |
| 7  | <p>a) Explain the frequency transformation technique in analog domain for converting lowpass to lowpass filter and lowpass to highpass filter with frequency response.</p> <p>b) Transform the prototype lowpass filter with following system function into a high pass filter with a cutoff frequency <math>\Omega_c^*</math></p> $H(S) = \frac{\Omega_c}{1 + 2\Omega_c S}$  | [L2][CO4] | [5M]  |
|    |   | [L2][CO4] | [5M]  |
| 8  | <p>a) What are the basic elements used to construct the block diagram of a discrete-time system? Draw their symbols.</p> <p>b) Construct the block diagram for the discrete-time systems whose input-output relations are described by the following difference equations:<br/>                     (i) <math>y(n) = 0.7x(n) + 0.3x(n-1)</math><br/>                     (ii) <math>y(n) = 0.5y(n-1) + 0.8x(n) + 0.4x(n-1)</math></p> | [L1][CO4] | [4M]  |
|    |   | [L3][CO4] | [6M]  |
| 9  | Explain and draw the following generalized realization structures of IIR filter<br>i) Direct form-I<br>ii) Direct form-II   | [L3][CO4] | 10M   |
| 10 | <p>Construct the Direct form I and Direct form II, of the LTI System described by the equation</p> $y(n) = -\frac{3}{4}y(n-1) + \frac{3}{32}y(n-2) + \frac{1}{64}y(n-3) + x(n) + 3x(n-1)$   | [L3][CO4] | [10M] |

**11** Construct the cascade and parallel form structure of the system with difference equation.

[L3][CO4] [10M]

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

**UNIT-IV**  
**FIR FILTERS**

- 1 a) What are the advantages of FIR filters? [L1][CO5] [2M]  
 b) What is the necessary and sufficient condition for the linear phase characteristic of a FIR filter? [L1][CO5] [2M]  
 c) Compare hamming and hanning window [L2][CO5] [2M]  
 d) What is the advantage of linear phase realization of FIR systems? [L2][CO5] [2M]  
 e) List the different types of structures for realizing FIR systems. [L2][CO5] [2M]
- 2 a) Discuss the characteristics of FIR filters with linear phase [L2][CO5] [5M]  
 b) The following transfer function characterizes an FIR filter ( $N = 9$ ). Determine the magnitude response and show that the phase and group delays are constant.  

$$H(z) = \sum_{n=0}^{N-1} h(n) z^{-n}$$
- 3 a) Explain the frequency response of linear phase FIR filters and classify them based on impulse response symmetry.” [L2][CO5] [5M]  
 b) Explain the Procedure for designing FIR filters using windows.
- 4 Design an FIR digital filter to approximate an ideal Lowpass filter with passband gain of unity, cutoff frequency of  $1kHz$ , and working at a sampling frequency  $f_s=4kHz$ . The length of the impulse responses should be 11. Use Fourier series method. [L3][CO5] [10M]
- 5 a) Explain the Procedure for designing FIR filters using windows. [L2][CO5] [4M]  
 b) Give the equations for Rectangular, Hanning and Hamming window and blackman [L2][CO5] [6M]
- 6 A Low pass filter is to be designed with the following desired frequency response using rectangular window for  $N=11$ . [L3][CO5] [10M]  

$$H(e^{j\omega}) = 1 \text{ for } -\frac{\pi}{2} \leq \omega \leq \frac{\pi}{2}$$

$$= 0 \text{ for } \frac{\pi}{2} \leq |\omega| \leq \pi$$
 Determine the filter coefficients  $h(n)$  if the window function is defined as  

$$w(n) = 1 \text{ for } -5 \leq n \leq 5$$

$$= 0 \text{ otherwise}$$
 Also determine the frequency response  $H(z)$  of the designed filter.
- 7 Design a filter with following data, using a Hamming window with  $N=7$ . [L3][CO5] [10M]  

$$H_a(e^{j\omega}) = 1 \text{ for } -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4}$$

$$= 0 \text{ for } \frac{\pi}{4} \leq |\omega| \leq \pi$$
- 8 Design an ideal Highpass filter using Hanning window with the frequency response [L3][CO5] [10M]  

$$H_a(e^{j\omega}) = 1 \text{ for } \frac{\pi}{4} \leq \omega \leq \pi$$

$$= 0 \text{ for } |\omega| \leq \frac{\pi}{4}$$
- 9 Find the values of  $h(n)$  for  $N=11$  and find  $H(z)$ . Draw the Linear Phase Structure and transversal structures for realizing the FIR filters and explain. [L2][CO5] [10M]
- 10 a) Construct the Direct form realization of system function. [L3][CO5] [5M]

$$H(Z)=1+2Z^{-1}-3Z^{-2}-4Z^{-3}+5Z^{-4}$$

- b) Construct the cascade realization of the system function. [L3][CO5] [5M]

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

- 11 a) Realize the H(Z) with minimum number of multipliers [L3][CO5] [5M]

$$1 + \frac{1}{2}Z^{-1} + \frac{1}{8}Z^{-2} + \frac{3}{4}Z^{-3} + \frac{1}{8}Z^{-4} + \frac{1}{2}Z^{-5} + Z^{-6}$$

- b) Discuss the comparison between IIR and FIR systems. [L3][CO5] [5M]

**UNIT-V**  
**Architectures for Programmable DSP Devices**

<b>1</b>	a) What are general purpose DSPs? Give one example.	[L1][CO6]	[2M]
	b) What is the function of Parallel Logic Unit?	[L1][CO6]	[2M]
	c) What are memory-mapped registers?	[L1][CO6]	[2M]
	d) What are the applications of on-chip timer?	[L1][CO6]	[2M]
	e) How many buses does C5X architecture have? Name them.	[L1][CO6]	[2M]
<b>2</b>	a) Explain the two categories of DSP's in detail.	[L2][CO6]	[5M]
	b) What are the advantages of the DSP processors over conventional microprocessors?	[L1][CO6]	[5M]
<b>3</b>	Draw and Explain the architecture of TMS320C5X digital signal processor in brief.	[L2][CO6]	[10M]
<b>4</b>	a) Describe about the bus structure of TMS320C5x DSP processor	[L2][CO6]	[5M]
	b) Describe the Auxiliary Register ALU (ARAU) and explain its role in address generation.	[L2][CO6]	[5M]
<b>5</b>	Explain the Central Arithmetic Logic Unit of TMS320C5x DSP with its components and functions.	[L2][CO6]	[10M]
<b>6</b>	a) Explain the function of Index Register and Block Move Address Register in TMS320C5x architecture.	[L3][CO6]	[5M]
	b) Explain the Parallel Logic Unit of TMS320C5x DSP and its importance in DSP operations.	[L2][CO6]	[5M]
<b>7</b>	a) What are memory-mapped registers? Explain their role in TMS320C5x DSP.	[L2][CO6]	[5M]
	b) Explain the program controller of TMS320C5x DSP and its main functions.	[L2][CO6]	[5M]
<b>8</b>	Explain the some flags of status register of TMS320C5x DSP.	[L1][CO6]	[10M]
<b>9</b>	a) Explain On-Chip memory of TMS320C5x in details.	[L2][CO6]	[5M]
	b) Discuss the various interrupts of TMS320C5X	[L2][CO6]	[5M]
<b>10</b>	Explain On-Chip Peripheral of TMS320C5x in details.	[L2][CO6]	[10M]
<b>11</b>	Explain about the Central Processing unit of TMS320C5X	[L2][CO6]	[10M]