SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: III B.Tech VI Semester **Regulation: R23**

Subject and Code: 23ECE361T- Digital Signal Processing

SYLLABUS

23ECE361T	**Digital Signal Processing**	**L T P C** **3 0 0 3**

COURSE OBJECTIVES:

1. To get familiar with the properties of discrete time signals, systems and z-transform.
2. To learn the importance of FFT algorithm for computation of Discrete Fourier Transform and Fast Fourier Transform with decimations.
3. To understand the implementations of digital filter structures.
4. To analyse the FIR filter design using Fourier series and windowing methods.
5. To gain the knowledge on Programmable DSP Devices.

UNIT I - DISCRETE TIME SIGNALS AND SYSTEMS & Z- TRANSFORM (9)

Introduction to digital signal processing, Review of discrete-time signals and systems, Analysis of discrete-time linear time invariant systems, frequency domain representation of discrete time signals and systems Definition, ROC, Properties, Poles and Zeros in Z-plane, the inverse Z Transform, System analysis, Transfer function.

UNIT II - DISCRETE FOURIER TRANSFORM & FAST FOURIER TRANSFORM (9)

Introduction, Discrete Fourier Series, properties of DFS, Discrete Fourier Transform, Inverse DFT, properties of DFT, Linear and Circular convolution, convolution using DFT, sampling, Quantization effects. Introduction, Fast Fourier Transform, Radix-2 Decimation in time and Decimation in frequency FFT, Inverse FFT (Radix-2).

UNIT III – IIR FILTERS (9)

Introduction to digital filters, Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital filters from analog filters by Impulse invariant and bilinear transformation methods, Frequency transformations, Basic structures of IIR Filters - Direct form I, Direct form-II, Cascade form and Parallel form realizations.

UNIT IV – FIR FILTERS (9)

Introduction, Characteristics of FIR filters with linear phase, Frequency response of linear phase FIR filters, Design of FIR filters using Fourier series and windowing methods (Rectangular, Triangular, Raised Cosine, Hanging, Hamming, Blackman), Comparison of IIR & FIR filters, Basic structures of FIR Filters – Direct form, Cascade form, Linear phase realizations.

UNIT V – ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES (9)

Architecture of TMS320C5X: Introduction, Bus Structure, Central Arithmetic Logic Unit, AuxiliaryRegister ALU, Index Register, Block Move Address Register, Parallel Logic Unit, Memory mapped registers, program controller, some flags in the status registers, On- chip memory, On-chip peripherals.

Total Hours: 45

Prepared by Dr.S.Sugumaran & Mr. S. Narendra Kumar

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COURSE OUTCOMES:

On successful completion of the course, students will be able to		POs
CO1	Familiar with the properties of discrete time signals, systems and z-transform.	PO1, PO2
CO2	Learn the importance of FFT algorithm for computation of Discrete Fourier Transform and Fast Fourier Transform with decimations.	PO1, PO2, PO3
CO3	Understand the implementations of digital filter structures.	PO1, PO2
CO4	Analyse the FIR filter design using Fourier series and windowing methods.	PO1, PO2, PO3
CO5	Gain the knowledge on Programmable DSP Devices.	PO1, PO2

TEXT BOOKS:

1. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education, 2007.
2. A.V.Oppenheim and R.W. Schaffer, Discrete Time Signal Processing, PHI.

REFERENCE BOOKS:

1. S.K.Mitra, Digital Signal Processing – A practical approach, 2nd Edition, Pearson Education, New Delhi, 2004.
2. MH Hayes, Digital Signal Processing, Schaum's Outline series, TATA Mc-Graw Hill, 2007.
3. Robert J. Schilling, Sandra L. Harris, Fundamentals of Digital Signal Processing using Matlab,

CO-PO MAPPING:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	3	-	-	-	-	-	-	-	-	-	-
CO.2	3	3	2	-	-	-	-	-	-	-	-	-
CO.3	3	3	-	-	-	-	-	-	-	-	-	-
CO.4	3	3	3	-	-	-	-	-	-	-	-	-
CO.5	3	3	-	-	-	-	-	-	-	-	-	-
CO*	3	3	2.5	-	-	-	-	-	-	-	-	-

Max Marks: 10

Prepared by Dr.S.Sugumaran & Mr. S. Narendra Kumar

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S.No.	CO	Questions	BT
UNIT I - DISCRETE TIME SIGNALS AND SYSTEMS & Z- TRANSFORM			
1	1	Explain the operations on signals. i. Shifting ii. Time reversal iii. Time scaling iv. Scalar multiplication v. Signal multiplier	L4
2	1	Check whether the following signal is linear or nonlinear, time variant or time invariant i. y(n)=2x(n)+(1/x(n-1) ii. $y(n) = nx^2(n)$	L2
3	1	Check whether the following signals iscausual, static or not (i) y(n) =ax(n) (ii) $y(n)=x(n^2)$ (iii) y(n)=x(n)+x(n+1) (iv) $y(n)=x^2(n)$	L2
4	1	Explain basic Elements of DSP and write advantages, disadvantages and application.	L2
5	1	Determine the following signals are energy or power signal, (i) x(n)=sin((π/3)n) (ii) $x(n)=(1/4)^n u(n)$	L2 L2
6	1	Explain the properties of Z-transformation (i)Lnearity (ii)Time shifting (iii)Differentiation	L4
7	1	(i) Discripte the Propoerties of ROC (ii) Given x(t)=sin(wn), Find Z-transformation	L4
8	1	(i)Given $X(Z)=1/(1-az^{-1})$, |z|>|a|, find x(n) by long division method. (ii) Determine the inverse Z-transforms of the following sequence $X(Z)=1/(1-1.5Z^{-1}+0.5Z^{-2})$	L2 L2
9	1	(Determine the inverse Z-transforms of the following sequence $X(Z)=(3+2Z^{-1}+Z^{-2})/(1-3Z^{-1}+2Z^{-2})$	L4

10	**1**	Explain the Z transformation Properties of Convolution.	**L3**
11	**1**	Determine the Z-transforms of the following sequence (i) x(n)={1,3,5,2,1} (ii) x(n)=u(n)	**L3**
S.No.	**CO**	**Questions**	**BT**
UNIT II - DISCRETE FOURIER TRANSFORM & FAST FOURIER TRANSFORM			
1	**2**	Compute the DFT of the sequence x(n)={0,1,2,3}, sketch the magnitude and phase spectrums.	**L2**
2	**2**	Determine the IDFT of the sequence X(k)={2, 1-j, 0, 1+j}	**L3**
3	**2**	Explain the properties of DFT (i) Periodicity (ii) DFT of complex conjugate sequence (iii) Magnitude and Phase function	**L2** **L2**
4	**2**	Determine the DFT -Circular convolution properties.	**L2**
5	**2**	Compute the circular convolution of the two sequence $x_1(n)=\{2,1,2,1\}$ and $x_2(n)=\{1,2,3,4\}$ using Graphical method.	**L4**
6	**2**	Compute the circular convolution of the two sequence $x_1(n)=\{2,1,2,1\}$ and $x_2(n)=\{1,2,3,4\}$ using DFT and IDFT method.	**L2**
7	**2**	Explain Radix-2 FFT method with Example.	**L3**
8	**2**	Compute the 8-point DFT of the sequence x(n) = {0.5,0.5,0.5,0.5,0,0,0,0} using the radix-2 DIT FFTalgorithm	**L5**
9	**2**	Compute the 8-point DFT of the sequence x(n) = {2,2,2,2,1,1,1,1} using the radix-2 DIT FFT algorithm	**L4**

10	**2**	Compute the 8-point DFT of the sequence $x(n) = \{2,1,2,1,2,1,2,1\}$ using the radix-2 DIF FFT algorithm	**L3**
11	**2**	Compute the FFT of the sequence x(n)=n+1 where N=8 using inplace of radix-2 decimation in Frequency algorithm	**L4**

S.No.	**CO**	**Questions**	**BT**
Unit III: IIR Filter			
1	**3**	(i) Explain IIR filter design using butterworth filter method. (ii) Describe IIR filter design by Impulse Invariant method	**L2**
2	**3**	(i) Illustrate IIR filter design using Chebysave filter method. (ii) Explain and write the advantage of IIR filter design by bilinear transformation Techniques.	**L2** **L2**
3	**3**	Obtain H(z) from H(s)=1/(S+1)(S+2) when T=1 second using impulse Invariant method.	**L2** **L2**
4	**3**	Determine H(z) from $H(s)=(S+0.2)/(S+0.2)^2+9$ when T=1 second using impulse Invariant method.	**L2** **L2**
5	**3**	Apply the bilinear transformation to H(s)=2/(s+1)(S+3) with T=0.1 sec and find H(Z).	**L2** **L4**
6	**3**	Design a digital butterworth filter that satisfies the following constraint using bilinear transformation. Assume T = 1 sec. $1/ \leq \lvert H(w)\rvert \leq 1$; for $0 \leq w \leq \pi/2$ $\lvert H(w)\rvert \leq 2$; for $3\pi/4 \leq w \leq \pi$	**L2** **L2**
7	**3**	Design a digital butterworth filter that satisfies the following constraint using bilinear transformation. Assume T = 1 sec. $0.7071 \leq \lvert H(w)\rvert \leq 1$; for $0 \leq w \leq 0.2\pi$ $\lvert H(w)\rvert \leq 0.08$; for $0.4\pi \leq w \leq \pi$	**L3**
8	**3**	Design a digital Chebyshev filter that satisfies the following constraint using bilinear transformation. Assume T = 1 sec. $0.8 \leq \lvert H(w)\rvert \leq 1$; for $0 \leq w \leq 0.2\pi$ $\lvert H(w)\rvert \leq 0.2$; for $0.32\pi \leq w \leq \pi$	**L5**

9	**3**	A Chebyshev low pass filter has to meet the following specifications i) Pass band gain of -1dB at $\Omega p = 4$ rad/sec ii) Stop band alternations greater than or equal to 20 dB at $\Omega s =$ 8 rad/sec Determine the transfer function H(s) of the chebye filter to meet the above specifications	**L4**
10	**3**	Find the digital network in direct form (1 and 2 method)of the system described by the difference equation. $y(n)=x(n)+0.5x(n-1)+0.4x(n-2)-0.6y(n-1)-0.7y(n-2)$	**L3**
11	**3**	(i) Obtain a cascade realization for the system function given below $H(z)= (1+2Z^{-1}+Z^{-2}) / (1-3/4Z^{-1}+1/8Z^{-2})$ **(ii)** Determine a parallel realization for the system function given below $H(z)= (1+Z^{-1}+Z^{-2}) / (1-1/2Z^{-1})(1+1/6Z^{-1})$	**L3**

S.No.	**CO**	**Questions**	**BT**
		Unit IV: FIR Filter	
1	**4**	Obtain the structure realization for following system with minimum number of multipliers (i) $H(z)=1/4+1/2Z^{-1}+3/4Z^{-2}+1/2Z^{-3}+1/4Z^{-4}$ **(ii)** $H(z)=(1+1/2Z^{-1}+Z^{-2}) (1+1/4Z^{-1}+Z^{-2})$	**L2**
2	**4**	(a) Write the procedure for FIR filter design by Fourier series method. (b) Write the Advantage and Disadvantage of Fourier series method in FIR filter designing.	**L3**
3	**4**	Design an ideal LPF using Fourier series method with a frequency response of $H(e^{jw})= 1$; **for** $-\pi/2 \le \lvert\omega\rvert \le \pi/2$ 0; **for** $\pi/2 \le \lvert\omega\rvert \le \pi$ Find the value of h(n) for N=11 and also find H(Z) and plot the magnitude response.	**L2**
4	**4**	Design a FIR Band pass filter having a following specification $H_d(e^{jw}) = e^{-j5\omega}$ for $\pi/4 \le \lvert\omega\rvert \le \pi/2$ $= 0$ for otherwise using Hamming window.	**L2**

5	**4**	Design a bandstop filter to reject frequencies in the range 1 to 2 rad/sec using recntangualr window with N=7.	**L3**
6	**4**	(a) Write the procedure for FIR filter design by window techniques. (b) Write the difference between rectangular window, hamming and hanning window	**L2**
7	**4**	Design a lowpass filter using Rectangular window by taking 9 samples of w(n) and with a cut-off frequency of 1.2 rad/sec.	**L2**
8	**4**	Design a highpass filter using hamming window with a cut-off frequency of 1.2 radians/sec and N=9.	**L2**
9	**4**	Design a FIR Low pass filter having a following specification $H_d(e^{jw}) = 1$ for $-\pi/2 \leq \lvert\omega\rvert \leq \pi/2$ $= 0$ for otherwise using Hanning window.	**L4** **L2**
10	**4**	Determine the filter coefficients h(n) using frequency sampling method of frequency response given by, $Hd(e^{jw}) = e^{j(N-1)w/2}$, for $0 \leq \lvert\omega\rvert \leq \pi/2$ $= 0$ for otherwise For N=7.	**L2**
11	**4**	Realize the system function $H(z)=1/2+1/3Z^{-1}+Z^{-2}+1/4Z^{-3}+Z^{-4}+1/3Z^{-5}+1/2Z^{-6}$ using Linear phase realization.	**L3**

S.No.	**CO**	**Questions**	**BT**
		UNIT V – ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES	
1	**5**	Explain the overall architecture of TMS320C5X with a neat block diagram and describe the function of each major unit.	**L2**
2	**5**	Describe the bus structure of TMS320C5X and explain how it supports parallel instruction execution.	**L3**
3	**5**	Discuss the Central Arithmetic Logic Unit (CALU) of TMS320C5X in detail. Explain its role in DSP operations.	**L2**

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4	**5**	Explain the Auxiliary Register ALU (ARAU) and its addressing modes with suitable examples.	**L3**
5	**5**	Analyze the role of the Index Register and Block Move Address Register (BMAR) in memory operations.	**L4**
6	**5**	Explain the Parallel Logic Unit (PLU) and justify its importance in high-speed signal processing.	**L4**
7	**5**	Describe the Program Controller and explain how instruction pipelining is achieved in TMS320C5X.	**L3**
8	**5**	Explain the memory-mapped registers and discuss their significance in system control and configuration.	**L2**
9	**5**	Discuss the Status Register of TMS320C5X and explain the function of important flags used during arithmetic operations.	**L3**
10	**5**	Describe the on-chip memory organization and on-chip peripherals of TMS320C5X. Evaluate their role in improving system performance.	**L5**

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating