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Subject with Code: DIGITAL SIGNAL PROCESSING (18EC0414)
Course & Branch: B.Tech – ECE& EEE
Year & Sem: III-B.Tech. & I-Sem.
Regulation: R18

UNIT –I
DISCRETE FOURIER TRANSFORM (DFT) & FAST FOURIER TRANSFORM (FFT)

1	**a**	Draw the basic butterfly structure for DIT-FFT & DIF-FFT algorithms.	[L1][CO1]	**[2M]**
	b	Find the DFT of a sequence x(n)={1,1,0,0 }	[L1][CO1]	**[2M]**
	c	Distinguish between linear and circular convolution	[L4][CO1]	**[2M]**
	d	State the difference between overlap save and overlap add method	[L5][CO1]	**[2M]**
	e	What is the relationship between Fourier series coefficients of a periodic sequence and DFT?	[L1][CO1]	**[2M]**
2		a) State and prove the following properties of DFT	[L5][CO1]	**[7 M]**
		b) Compare DFT and FFT algorithms.	[L5][CO1]	**[3 M]**
3		Compute 8-point DFT of the sequence x(n)= {1,2,3,4,4,3,2,1} using radix-2 DIT-FFT Algorithm.	[L5][CO1]	**[10 M]**
4		a) Explain decimation in time FFT algorithm with necessary expressions.	[L5][CO1]	**[7 M]**
		b) Compare radix-2 DIT-FFT and DIF-FFT algorithms.	[L5][CO1]	**[3M]**
5		Determine the 8 point DFT of the sequence x(n)={1,1,1,1,1,1,0,0}	[L5][CO1]	**[10M]**
6		a) Identify 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 add method.	[L2][CO1]	**[5M]**
		b) Compute the IDFT of a sequence Y(K)={1,0,1,0 }	[L5][CO1]	**[5M]**
7		a) Explain decimation in frequency FFT algorithm with necessary expressions.	[L5][CO1]	**[7 M]**
		b) Summarize the differences and similarities between DIF & DIT FFT algorithms?	[L5][CO1]	**[3 M]**
8		a) Compute the DFT of a sequence x(n)={1,1,0,0 }	[L5][CO1]	**[5 M]**
		b) Identify the output y(n) of a filter whose impulse response is h(n)=[1,2] and input signal x(n)= [1,2,-1,2,3,-2,-3,-1,1,1,2,-1] using overlap save method	[L2][CO1]	**[5 M]**
9		Compute 8-point DFT of the sequence x(n)= {0,1,2,3,4,5,6,7} using radix-2 DIF-FFT Algorithm.	[L5][CO1]	**[10 M]**
10		a) Compute the 4-point DFT of the sequence and plot magnitude and phase response $x(n) = \{ 1 ; 0 \le n \le 2)$ $= 0$; otherwise	[L5][CO1]	**[7 M]**
		b) Explain the relationship between DFT to the Z-Transform	[L5][CO1]	**[3 M]**
11		Compute IDFT of the sequence x(n)= {7, -0.707-j0.707, -j, 0.707-j0.707,1, 0.707+j0.707, j, - 0.707+j0.707} using DIT FFT algorithm.	[L5][CO1]	**[10 M]**

UNIT –II

INFINITE IMPULSE RESPONSE FILTERS & REALIZATION OF IIR FILTER

1	**a**	What is necessity of Pre-warping?	[L1][CO2]	**[2M]**
	b	Describe impulse invariant method of designing IIR filter.	[L1][CO2]	**[2M]**
	c	What is the main disadvantage of direct form realization?	[L1][CO3]	**[2M]**
	d	What are the properties of bilinear transformation?	[L1][CO2]	**[2M]**
	e	What are the advantage and disadvantage of bilinear transformation?	[L1][CO2]	**[2M]**
2		a) For the analog transfer function H(s) = $\frac{2}{(S+1)(s+2)}$, Determine H(z) using impulse invariance method. Assume T=1 Sec.	[L6][CO2]	**[5 M]**
		b) Apply Bilinear transformation to H(s) = $\frac{2}{(S+1)(s+2)}$ with T=1 Sec and find H(z).	[L3][CO2]	**[5 M]**
3		a) An LTI System is described by the difference equation $y(n)+a_1y(n-1)=x(n)+b_1x(n-1)$. Determine its direct form I structure.	[L5][CO3]	**[5 M]**
		b) Construct the cascade form structure of the system with difference equation $y(n)=\frac{3}{4}y(n-1) - \frac{1}{8}y(n-2) + x(n) + \frac{1}{3}x(n-1)$	[L3][CO2]	**[6 M]**
4		a) For the given specification, determine the order of the filter by Butterworth model. αp = 1 dB, αs = 30 dB, Ωp = 200 rad / sec, Ωs = 600 rad / sec.	[L5][CO1]	**[6M]**
		b) Explain the steps to be followed to design an analog chebyshev low pass filter	[L5][CO1]	**[4 M]**
5		a) Construct the parallel form structure of the system with difference equation $y(n)=\frac{3}{4}y(n-1) - \frac{1}{8}y(n-2) + x(n) + \frac{1}{3}x(n-1)$	[L3][CO1]	**[7 M]**
		b) List the Butterworth polynomials for order 1 to 5 and give its significance	[L4][CO1]	**[3 M]**
6		a) Explain the steps to be followed to design an analog Butterworth filter.	[L5][CO1]	**[3 M]**
		b) For the given specifications, Determine H(s) using Chebyshev approximation for the αp = 3 dB and αs =16 dB; fp=1 KHz and fs= 2 KHz.	[L5][CO2]	**[7 M]**
7		Apply the bilinear transformation, to design a high pass filter, monotonic in pass band with cut off frequency of 1000 Hz and down 10dB at 350 Hz. the sampling frequency is 5000Hz.	[L3][CO2]	**[10M]**
8		a) Sketch the direct form I and direct form II realization of the LTI System described by the equation $y(n)=-\frac{3}{8}y(n-1) + \frac{3}{32}y(n-2) + \frac{1}{64}y(n-3) + x(n) + 3x(n-1)$	[L3][CO3]	**[6 M]**
		b) An LTI System is described by the governing equation $y(n)+a_1y(n-1)=x(n)+b_1x(n-1)$. Realize it in direct form II structure	[L3][CO3]	**[4 M]**
9		a) Determine the order of analog Butterworth filter that has 2 dB passband attenuation at a frequency of 20 rad/sec and atleast 10 dB stopband attenuation at 30 rad/sec	[L5][CO2]	**[3 M]**
		b) Determine the transfer function H(s) for analog Butterworth filter that has 2 dB passband attenuation at a frequency of 20 rad/sec and atleast 10 dB stopband attenuation at 30 rad/sec.	[L5][CO2]	**[7 M]**
10		Determine an analog chebyshev filter transfer function that satisfies the constraints $\frac{1}{\sqrt{2}} \leq \lvert H(j\Omega)\rvert \leq 1$; $0 \leq \Omega \leq 2$ $\lvert H(j\Omega)\rvert < 0.1$; $\Omega \geq 4$	[L5][CO2]	**[10 M]**
11		a) Describe impulse invariant method of designing IIR filter.	[L3][CO2]	**[3M]**
		b) Explain the different types of IIR filter realization with suitable example.	[L5][CO3]	**[7 M]**

UNIT –III

FINITE IMPULSE RESPONSE FILTERS & REALIZATION OF FIR FILTER

1	**a**	Define Gibb's phenomenon.	[L1][CO2]	**[2M]**
	b	State and explain the properties of FIR filters.	[L1][CO2]	**[2M]**
	c	What are the desirable characteristics of windows?	[L1][CO2]	**[2M]**
	d	What is the basis for Fourier series method of FIR filter design? Why truncation is necessary?	[L1][CO3]	**[2M]**
	e	What is recursive and non-recursive realization?	[L1][CO3]	**[2M]**
2		a) Explain briefly how zeros are located in FIR Filter?	[L5][CO1]	**[4 M]**
		b) Summarize the advantages and disadvantages of FIR Filters	[L4][CO1]	**[3 M]**
		c) List the desirable characteristics of the window	[L1][CO1]	**[3 M]**
3		Design an ideal High pass filter with the frequency response $H_d(e^{jw}) = 1 \quad for \ \frac{\pi}{4} \le \lvert\omega\rvert \le \pi$ $= 0 \qquad \lvert\omega\rvert \le \frac{\pi}{4}$ Find the values of h(n) for N=11. Find H(z) and plot the magnitude response	[L6][CO3]	**[10M]**
4		a) Explain the Fourier Series method of Designing FIR Filters.	[L5][CO3]	**[5 M]**
		b) Distinguish between FIR and IIR Filter.	[L5][CO3]	**[5 M]**
5		Design an ideal Low pass filter with a frequency response $H_d(e^{jw}) = 1 \quad for -\frac{\pi}{2} \le \lvert\omega\rvert \le \frac{\pi}{2}$ $= 0 \qquad \frac{\pi}{2} \le \lvert\omega\rvert \le \pi$ Find the values of h(n) for N=11. Find H(z) and plot the magnitude response	[L6][CO3]	**[10M]**
6		Determine the coefficients of a linear phase FIR filter of length N=15 which has a symmetric unit sample response and a frequency response that satisfies the conditions. $H(2\pi k/15) = 1$ for k=0,1,2,3 $= 0$ for k=4, 5, 6, 7	[L5][CO3]	**[10M]**
7		a. Determine the Direct form realization of system function $H(z) = 1 + 2z^{-1} - 3z^{-2} - 4z^{-3} + 5z^{-4}$	[L5][CO3]	**[5 M]**
		b. Obtain the linear phase realization of the system function $H(z) = \frac{1}{2} + \frac{1}{3}z^{-1} + z^{-2} + \frac{1}{4}z^{-3} + z^{-4} + \frac{1}{3}z^{-5} + \frac{1}{2}z^{-6}$	[L5][CO3]	**[5 M]**
8		Determine the coefficients h(n) of a linear phase FIR filter of length M = 15 which has a symmetric unit sample response and a frequency response that satisfies the condition $H(2\pi k/15) = 1$ for k = 0, 1, 2, 3 $= 0.4$ for k = 4 $= 0$ for k = 5, 6, 7	[L5][CO3]	**[10M]**
9		(a) Explain the design steps of FIR filters using windows.	[L5][CO3]	**[5 M]**
		(b)State and explain the properties of FIR filters. State their importance.	[L5][CO3]	**[5 M]**
10		(a) Construct the cascade realization of FIR Filters for the function $H(z) = (1 + 2z^{-1} - z^{-2})(1 + z^{-1} - z^{-2})$	[L6][CO3]	**[5 M]**
		(b) What is linear phase filter? What are the conditions to be satisfied by the impulse response of an FIR system in order to have a linear phase?	[L1][CO3]	**[5 M]**
11		Design an ideal Band pass filter with the frequency response $H_d(e^{jw}) = 1 \quad for \ \frac{\pi}{4} \le \lvert\omega\rvert \le \frac{3\pi}{4}$ $= 0 \qquad Otherwise$ Find the values of h(n) for N=11. Find H(z) and plot the frequency response	[L6][CO3]	**[10M]**

UNIT –IV
FINITE WORD LENGTH EFFECTS

1	**a** What is Dead band of a filter?	[L1][CO5]	**[2M]**
	b How to prevent limit cycle oscillations.	[L1][CO5]	**[2M]**
	c Compare fixed and floating-point arithmetic.	[L4][CO5]	**[2M]**
	d What is meant by input quantization error?	[L1][CO5]	**[2M]**
	e What is the effect of quantization on pole location?	[L1][CO5]	**[2M]**
2	a. Represent the following numbers in floating point format with five bits for mantissa and three bits for exponent. a) 7_{10} b) 0.25_{10} c) -7_{10} d) -0.25_{10}	[L3][CO5]	**[5 M]**
	b. Discuss the various common methods of quantization.	[L2][CO5]	**[5 M]**
3	a. What is quantization of analog signals? Derive the expression for the quantization error.	[L1][CO5]	**[5 M]**
	b. Explain in detail the effects of input quantization error.	[L5][CO5]	**[5 M]**
4	a. How to prevent limit cycle oscillations? Explain.	[L1][CO5]	**[5 M]**
	b. What is a dead band of a filter? Explain.	[L1][CO5]	**[5 M]**
5	a. Compare floating point with fixed point arithmetic.	[L5][CO5]	**[5 M]**
	b. What is quantization noise? Derive the expression for quantization noise power.	[L1][CO5]	**[5 M]**
6	(a)Tabulate the Quantization error ranges of truncation and rounding for the various number representations.	[L2][CO5]	**[5 M]**
	(b) Draw and explain the power density functions for truncation and rounding.	[L5][CO5]	**[5 M]**
7	Explain the characteristics of limit cycle oscillation with respect to the system described by the difference equation y(n) = 0.7 y(n-1) + x(n). Determine the dead band range of the system.	[L5][CO5]	**[10 M]**
8	The output signal of an A/D converter is passed through a first order low pass filter with transfer function H(Z) = (1-a)z/ (z-a) for 0< a <1. Find the steady state output noise power due to quantization at the output of the digital filter.	[L1][CO5]	**[10 M]**
9	(a) With relevant expressions and Quantization noise model discuss steady state input noise power.	[L2][CO5]	**[5 M]**
	(b) Discuss about the steady state output noise power.	[L2][CO5]	**[2M]**
10	a. Discuss in detail the errors resulting from rounding and truncation.	[L2][CO5]	**[5 M]**
	b. Summarize the various forms of representing the numbers in digital systems	[L2][CO5]	**[5 M]**
11	Explain the characteristics of a limit cycle oscillation with respect to the system described by the equation y(n)=0.95y(n-1) + x(n), when the product is quantized to 5 bits by rounding. The system is excited by an input x(n)=0.75 for n=0 and x(n)=0 for n≠0. Also, determine the dead band of the filter.	[L5][CO5]	**[10M]**

UNIT –V
INTRODUCTION TO DIGITAL SIGNAL PROCESSORS

1	**a** Mention the applications of PDSP's.	[L1][CO6]	**[2M]**
	b What are the different buses of TMS320C5X?	[L1][CO6]	**[2M]**
	c Draw the block diagram of VonNumann Architecture	[L1][CO6]	**[2M]**
	d What are the advantages and disadvantages of VLIW architecture?	[L1][CO6]	**[2M]**
	e Define Pipelining?	[L1][CO6]	**[2M]**
2	With a neat sketch explain the architecture of TMS 320C50 processor.	[L5][CO6]	**[10 M]**
3	(a)What are the different buses of TMS320C5X and their functions?	[L1][CO6]	**[5 M]**
	(b) Brief about the overview of digital signal processors.	[L4][CO6]	**[5 M]**
4	(a) List the functional units in Central Processing Unit of 5X.	[L1][CO6]	**[5 M]**
	(b) Explain the function of CALU in detail.	[L5][CO6]	**[5 M]**
5	(a) What is meant by memory mapped register? How is it different from a memory?	[L1][CO6]	**[5 M]**
	(b) Discuss the various Circular Buffer Registers in detail.	[L2][CO6]	**[5 M]**
6	(a) List status register bits of 5X and their functions.	[L1][CO6]	**[5 M]**
	(b) Discuss the Block repeat registers (RPTC, BRCR, PASR and PAER).	[L2][CO6]	**[5 M]**
7	(a) List the various on-chip peripherals interfaced with 5X.	[L1][CO6]	**[5 M]**
	(b) Explain the function of Serial port interface.	[L5][CO6]	**[5 M]**
8	(a)Categories the various interrupt types supported by 5X?	[L2][CO6]	**[5 M]**
	(b) Draw and explain the architecture of von Neumann.	[L5][CO6]	**[5 M]**
9	(a) Distinguish between the dual-access RAM and single-access RAM used in the on-chip memory of 5X.	[L5][CO6]	**[5 M]**
	(b) Discuss the advantages and disadvantages of VLIW architecture**.**	[L1][CO6]	**[5 M]**
10	(a) Explain in detail the application of PDSP's in the field of communication systems.	[L5][CO6]	**[5 M]**
	(b) Discuss the role of PDSP in multimedia applications.	[L6][CO6]	**[5 M]**
11	(a)List the on-chip memory in 5X and explain their functions.	[L1][CO6]	**[5 M]**
	(b) Compare the various architectures employed in designing a digital signal processor.	[L5][CO6]	**[5 M]**

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