Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Program: B Tech ECE **Semester: IV**
Course: Digital Signal Processing **Time 03 hrs.**
Course Code: ECEG2013 **Max. Marks: 100**
Nos. of page(s) : 3

Instructions:

- Attempt all questions as per the instruction.
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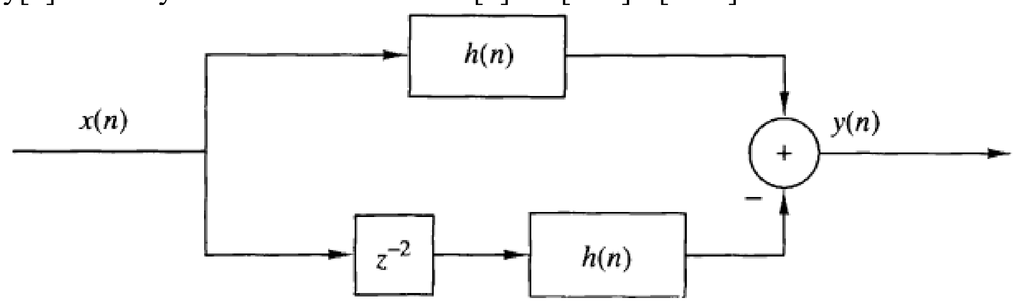
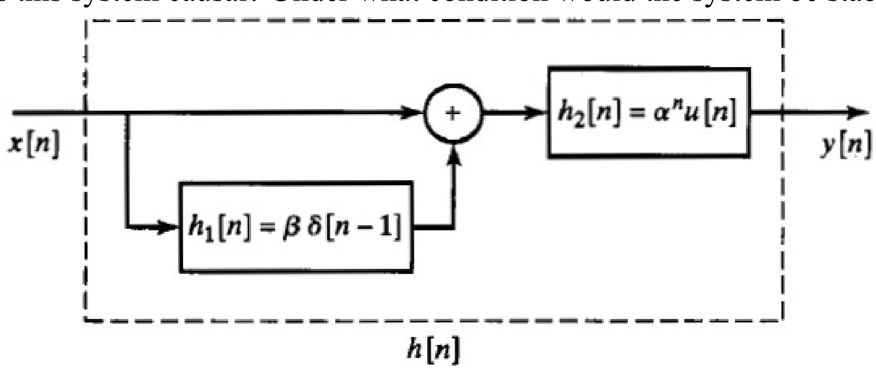
- Unless otherwise indicated symbols and notations have their usual meanings.
- Strike off all unused blank pages

SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	Define causality and stability of LTI discrete-time system with mathematical relations.	**4**	**CO1**
Q 2	Define cross-correlation and auto-correlation sequence. Also write relation between linear convolution and correlation	**4**	**CO1**
Q 3	Compute 4-point DFT of the signal $x[n]=\{1,-1,-1,0\}$ using decimation in time FFT algorithm.	**4**	**CO2**
Q 4	Define the following terms: Phase delay, Group delay, linear phase response.	**4**	**CO3**
Q 5	(a) Draw the block diagram of the system that represented by the following difference equation: $y[n]=b_0 x[n]+b_1 x[n-1]+a_1 y[n-1]$ (b) Draw the magnitude characteristics of Chebyshev low pass filter (Type-I and Type-II) and label the specifications on its magnitude response plot.	**2+2**	**CO4**

SECTION B (40 Marks)

S. No.		Marks	CO
Q 6	(a) Given sequence $x[k]=\begin{cases} 2; k=0,1,2 \\ 1; k=3,4 \\ 0; otherwise \end{cases}$ Sketch the sequence x[k] and the reverse sequence $x[-k]$, the shifted sequences $x[-k+2]$ and $x[-k-3]$. (b) Find the discrete time convolution sum of the following $y[n]=x[n]*u[n-2]$. Where $x[n]=3^n u[-n+3]$.	**4+4**	**CO1**
Q 7	Let X[k] be a 14-point DFT of sequence x[n]. the first eight samples are given by X[0] = 12, $X[1]=-1+3j$, $X[2]=3+4j$, $X[3]=1-5j$, $X[4]=-2+2j$, $X[5]=6+3j$, $X[6]=-2-3j$, X[7] = 10. Determine the remaining samples of X[k]. Evaluate the following function of x[n] without computing the IDFT of X[k].	**8**	**CO2**

	(i) x[0] (ii) $\sum_{n=0}^{13} x[n]$ (iii) $\sum_{n=0}^{13} x[n]e^{\frac{j4\pi}{7}n}$ (iv) $\sum_{n=0}^{13} \lvert x[n]\rvert^2$		
Q 8	(a) Explain how IIR digital filters are designed from analog filters (b) Consider the following Laplace transfer function: $H(s)=\frac{s+5}{(s+2)(s^2+3s+2)}$ Determine H(z) and the difference equation using the impulse invariant method if the sampling rate is 10 Hz.	**3+5**	**CO3**
Q 9	Given a filter transfer function, $H(z)=\frac{0.5(1-z^{-2})}{(1+1.3z^{-1}+0.36z^{-2})}$ (a) Realize the digital filter using direct form I and using direct form II; (b) Determine the difference equations for each implementation.	**8**	**CO4**
Q 10	Consider the system in **Fig.1** with $h[n]=a^n u[n], -1<a<1$. Determine the response y[n] of the system to the excitation x[n] = u[n+5]-u[n-10]  **Fig. 1** **OR** Consider the system shown in **Fig.2.** (a) Find the overall impulse response of the system h[n]. (b) Is this system causal? Under what condition would the system be stable?  **Fig.2**	**8**	**CO1**

SECTION-C (40 Marks)			
Q 11	A band pass filter with Butterworth magnitude-frequency response satisfies the following specifications: Passband: 0.3 – 3.4 kHz Stopband: 0 – 0.2 kHz and 4 – 8 kHz Pass band ripple= 3 dB Stop band attenuation = 25 dB Sampling frequency = 32 kHz Obtain a suitable transfer function for the filter using the bilinear transformation method and realize the filter in direct form-I and II. **OR** Design a 5-tap FIR band pass filter with a lower cutoff frequency of 1,600 Hz, an upper cutoff frequency of 1,800 Hz, and a sampling rate of 8,000 Hz using (a) Rectangular window function (b) Hamming window function.	**20**	**CO3, CO4**
Q 12	In a speech recording system with a sampling rate of 10,000 Hz, the speech is corrupted by broadband random noise. To remove the random noise while preserving speech information, the following specifications are given: Speech frequency range 0–3,000 kHz Stopband range 4,000–5,000 Hz Passband ripple = 0.1 dB Stopband attenuation = 60 dB (a) Design the FIR filter to remove random noise with the above specifications using Kaiser Window method. (b) Determine the difference equation and realize the FIR filter with suitable structure.	**15+5**	**CO3, CO4**

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SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	For each impulse response listed below, determine whether the corresponding system is causal and stable (a) $h[n]=2^n u[-n]$ and (b) $h[n]=e^{2n}u[n-1]$	4	CO1
Q 2	Find the response of y[n] + y[n +1] - 2y[n - 2] = u[n] + 2u[n - 2] for the following initial values y[-1] = ½ ; y[-2] = ¼	4	CO1
Q 3	Find 4-point DFT of the following sequence $x[n]=\left(\frac{1}{2}\right)^n$	4	CO2
Q 4	Discuss in detail about frequency transformations.	4	CO3
Q 5	(c) A discrete time system is operated on an input sequence to produce an output sequence according to some computation algorithm: $y[n]=\sum_{k=0}^{M} b_k x[n-k]+\sum_{k=1}^{N} a_k y[n-k]$ Find its transfer function (d) Obtain the difference equation to represent the discrete time system of the **Fig.1** given below	2+2	CO4

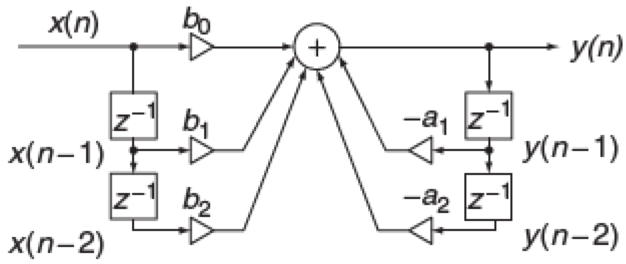
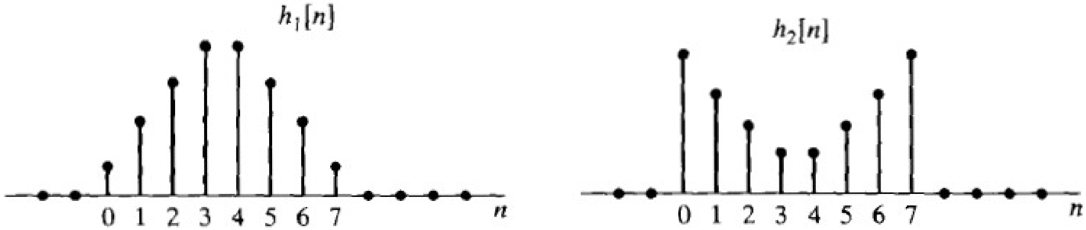


Fig.1

SECTION B (40 Marks)

Q 6	Compute linear and circular convolution of the following sequences: $x[n]=\{1,-2,3,-1\} \wedge h[n]=\{3,2,1,0\}$. Both signals are defined for $0 \le n \le 3$	**8**	**CO1**
Q 7	(a) Compute the circular convolution of the sequences $x_1[n]$ = {1, 2, 0, 1} and $x_2[n]$ = {2, 2, 1, 1} using DFT approach. (b) If X[k] is the 5-point DFT of the sequence $x[n]=2\delta[n]+\delta[n-1]+\delta[n-3]$. What sequence y[n] has a 5-point DFT $Y[k]=2X[k]\cos\left(\frac{6\pi k}{10}\right)$	**4+4**	**CO2**
Q 8	(a) A second-order band pass filter is required to satisfy the following specifications: Sampling rate = 8,000 Hz 3 dB bandwidth: BW = 100 Hz Narrow passband centered at 2,000 Hz Zero gain at 0 Hz and 4,000 Hz. Find the transfer function and difference equation by the pole-zero placement method. (b) Find the order and poles of a low pass Butterworth filter that has a 3db bandwidth of 400 Hz and an attenuation of 20db at 1KHz	**4+4**	**CO3**
Q 9	Given a fourth-order filter transfer function $H(z)=\frac{(0.343z^2+0.6859z+0.343)(0.4371z^2+0.8742z+0.4371)}{(z^2+0.7075z+0.7313)(z^2-0.1316z+0.1733)}$ (a) Realize the digital filter using the cascade (series) form via second order sections using the direct form II; (b) Determine the difference equations for implementation	**8**	**CO4**
Q 10	Two finite duration sequences $h_1[n]$ and $h_2[n]$ of length 8 are sketched in **Fig.2.** they are related by a circular shift i.e. $h_2[n]=h_1[(n-m)_8]$. (a) What is the value of m and specify whether the magnitude of 8-point DFTs of $h_1[n]$ and $h_2[n]$ are equal. (b) Which of the following statement is correct? Justify your answer. (i) $h_1[n]$ is better low pass filter than $h_2[n]$ (ii) $h_2[n]$ is better low pass filter than $h_2[n]$	**8**	**CO1, CO2**

	 **Fig.2** **OR** Consider a system with input x[n] and output y[n]. the input-output relation for the system is defined by the following two properties: $y[n]-ay[n-1]=x[n] \wedge y[0]=1$ (a) Determine whether the system is time invariant. (b) Determine whether the system is linear.		
SECTION-C (40 Marks)			
Q 11	(a) Design a digital band pass filter using bilinear transformation with a Butterworth filter characteristics satisfies the following specifications: pass band edge frequencies: 200 Hz and 300 Hz; pass band edge frequencies: 50 Hz and 450 Hz; a passband ripple of 3 dB; stop-band attenuation of 20dB, and a sampling frequency of 1,000 Hz. (b) Determine difference equation and realize the above filter using direct form – I and II **OR** Determine the transfer function for a 7-tap FIR low pass filter with a cutoff frequency of 2,000 Hz and a sampling rate of 8,000 Hz using the frequency sampling method. Also, realize the filter structure using direct form-II.	**15+5**	**CO3, CO4**
Q 12	(a) Design a low pass digital FIR filter using Kaiser Window satisfying the specifications given below: Pass band cut-off frequency = 100 Hz. Stop band cut-off frequency = 200 Hz. Pass band ripple = 0.1dB Stop band attenuation = 20 dB and Sampling frequency = 1000 Hz. (b) Determine the difference equation of this filter and realize with suitable structure.	**15+5**	**CO3, CO4**