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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

V Semester B. E. Examinations Nov/Dec-19

Electronics and Communication Engineering

DIGITAL SIGNAL PROCESSING

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

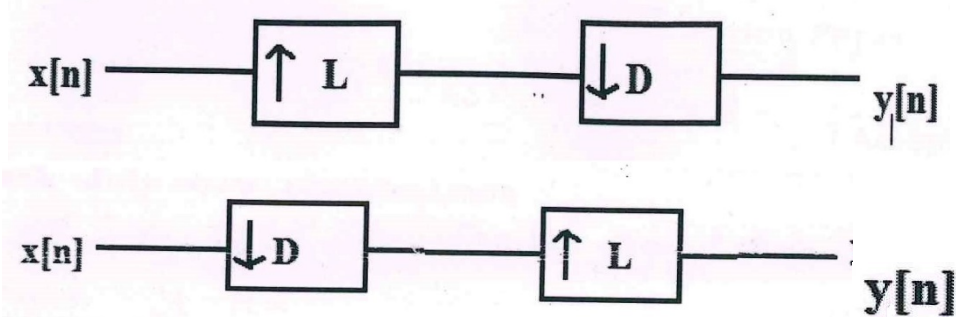
PART-A

1	1.1	The impulse response of a digital FIR filter is: $h(n) = \delta(n) - 2\delta(n-1) + 3\delta(n-2) + 2\delta(n-3) - \delta(n-4)$ Does this exhibit linear phase response?	01
	1.2	For the given low pass type I Chebyshev filter, find the order of filter for the given value of $d = 0.077$ and $K = 0.769$.	02
	1.3	For the given input sequence $x(n) = \delta(n-1)$, obtain the output for $y(n) = x(2n)$.	01
	1.4	What is frequency warping?	02
	1.5	The locus of Chebyshev filter and Butterworth filter is _____.	01
	1.6	Find the cut-off frequency of an third order Butterworth IIR filter with a passband edge frequency 200 rad/sec and passband ripple $\leq 2dB$.	02
	1.7	Write the relationship between 'S' and 'Z' in bilinear transformation method.	01
	1.8	The specification of a multistage lowpass filter is $f_p = 450Hz$, stopband $f_s = 500Hz$, Sampling frequency = $50kHz$, compute decimation factor.	02
	1.9	For stopband attenuation of $55dB$, _____ type of window satisfies the requirement?	01
	1.10	The transfer function of a normalized 3^{rd} order Butterworth filter has 3-poles. If one pole lies at $S = (-0.5 + j0.8660)$, find the location of the remaining two poles.	02
	1.11	For the given input sequence $x[n] = [1,3,4,6,7]$. Find the output sequence for $L = 2$ and $D = 2$.	02
	1.12	For a given design if $L = M$ then such filters are called _____.	01
	1.13	Determine the polyphase decompositions for the following FIR filters. $H(z) = 1 + 2z^{-1} + 3z^{-2} + 4z^{-3} + 5z^{-4} + 6z^{-5}$ for $M = 2$	01
	1.14	In signal reconstruction, M-band filter of non decimated case $h(nM) =$ _____.	01

PART-B

2	a	Convert the analog filter with system function $H(s) = \frac{(s+0.1)}{(s+0.1)^2+16}$ into a digital IIR filter by mean of the Bilinear transformation. The digital filter is to have a resonant frequency of $w_r = \Pi/2$.	08

	b	An digital lowpass filter is required to meet the following specifications: $Passband\ ripple\ < 1dB$ $Passband\ edge: 4kHz$ $Stopband\ attenuation\ \geq 40dB$ $Stopband\ edge: 6kHz$ $Sample\ rate: 24kHz$ Determine the required filter order for i) A Digital Butterworth filter ii) A Digital Chebyshev filter using Bilinear transformation on an analog system function.	08
3	a	A low pass filter is designed to obtain the following frequency response: $$H_d(w) = \begin{cases} e^{-j2w}, & |w| \leq \pi/4 \\ 0, & \pi/4 < |w| < \pi \end{cases}$$ Calculate the filter coefficient $h_d(n)$ and $h(n)$, if $w(n)$ is a rectangular window of length 5.	10
	b	Let the coefficient of a 3 stage FIR lattice structure be $k_1 = 0.5$, $k_2 = 0.4, k_3 = 0.2$ find the coefficients of direct form I FIR filter and draw its block diagram.	06
		OR	
4	a	The desired frequency response of a lowpass filter is $$H_d(w) = \begin{cases} e^{-j3w}, & |w| \leq 3\pi/4 \\ 0, & otherwise \end{cases}$$ Determine the frequency response of the FIR filter if Hamming window is used with $N = 7$.	10
	b	Realize the linear phase FIR filter having the following impulse response $h(n) = \delta(n) + \left(\frac{1}{4}\right)\delta(n-1) - \left(\frac{1}{8}\right)\delta(n-2) + \left(\frac{1}{4}\right)\delta(n-3) + \delta(n-4)$	06
5	a	Determine the poly-phase representation of following FIR filter and draw the structure. Let $M = .2$ i) $H(z) = 1 + 2z^{-1} + 3z^{-2} + 4z^{-3} + 5z^{-5} + 6z^{-6}$ ii) $h[n] = 0.5^n U[n]$	06
	b	Consider a sinusoidal signal $x(n) = 5\cos(0.1\pi n)$. Determine the frequency spectrum of the sampled signal $v(n) = \delta_3(n)x(n)$.	10
		OR	
6	a	Design a lowpass filter to pass a signal with a bandwidth of $25Hz$ and to reject above $30Hz$, with an attenuation of at least $60dB$. The sampling frequency is $6kHz$. i) Using FIR filtering with a windowing technique, determine the order of the filter. ii) Design a multistage lowpass filter in three stages ($D = 10 \times 5 \times x$). Find x and then compute the total number of operations per second.	10

	b	Consider the two different ways of cascading decimator with an interpolator shown in Fig. 6.b  Fig 6b Show the output of two configurations are different if $D = L = 2$.	06
7	a	An FIR filter has a transfer function of $H(z) = 2 + z^{-1} - z^{-2} + 0.5z^{-3}$ and frequency response $H(w)$. Determine the impulse response of the filter $F(z)$ with frequency response $H(W - 0.2\Pi)$.	08
	b	Construct DFT filter bank for $M = 4$. Write relevant expressions and polyphase implementation.	08
8	a	Explain the following with a block diagram: i) Sub band coding of speech signals. ii) Touch tone generation and reception for digital telephones.	10
	b	With a neat diagram, explain the interfacing of digital system with different sampling rate.	06