Hall Ticket Number:

Code No.: 5122 M

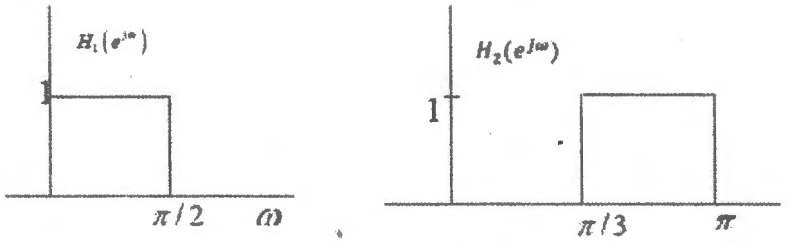
VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD
M.E. I Year (E.C.E.) I-Semester (Make Up) Examinations, March-2016
(Communication Engineering & Signal Processing)
Multirate Signal Processing

Time: 3 hours Max. Marks: 70

*Note: Answer **ALL** questions in **Part-A** and any **FIVE** questions from **Part-B***

Part-A (10 X 2=20 Marks)

1. Define linearity and time-invariance of a discrete time system.
2. The Fourier transforms of the impulse responses, $h_1(n)$ and $h_2(n)$ of two LTI systems are as shown in figure below



Find the Fourier transform of the impulse response of the overall system, when they are connected in parallel.

3. Determine the number of additions, multiplications and memory locations required for direct form II realization of an IIR digital filter transfer function having numerator polynomial of order M and denominator polynomial of order N.
4. Write the conditions on the impulse response h(n) of an FIR filter to have linear phase.
5. A speech signal $x(t)$ is digitized at a sampling rate of 16 KHz. The speech signal was destroyed once the sequence $x(n)$ was stored on a magnetic tape. Later it was required to obtain the speech signal sampled at the standard 8 KHz used in telephony. Draw the schematic diagram to do this using discrete time processing.
6. Determine the polyphase transfer functions $E_0(z)$,*and* $E_1(z)$ for two-branch polyphase realization of a length-6 FIR filter.
7. Check for perfect reconstruction of two-channel filter bank for the following analysis and synthesis filters: $H_0(z)=2-z^{-1}$, $H_1(z)=2+3z^{-1}$, $G_0(z)=-1+1.5z^{-1}$, $G_1(z)=1+0.5z^{-1}$.
8. Obtain the perfect reconstruction condition for linear Phase FIR PR QMF Banks.
9. Obtain Haar wavelet and plot it for wavelet coefficients $h_1(0)=\frac{1}{\sqrt{2}}$ and $h_1(1)=-\frac{1}{\sqrt{2}}$
10. Write the dilation equations using scaling coefficients and wavelet coefficients.

Part-B (5 X 10=50 Marks)

11. a) An initially relaxed LTI system was tested with an input signal x(n) = 2u(n), and found to have a response as shown in the following table [4]

n	1	2	3	4	5	.....	100	.....
y(n)	2	4	8	12	20	.....	20	.....

i) Obtain the impulse response of the system
ii) Deduce the difference equation of the system

b) Consider the system shown in Figure 1, where $H(e^{j\omega})$ is an ideal LTI low pass filter with cutoff of $\pi/8$ rad/sec and the spectrum of $x_a(t)$ is shown in Figure 2. [6]

i) What is the maximum value of T to avoid aliasing in the ADC?
ii) If *1/T*=10 kHz, then what will be the spectrum of $y_r(t)$.

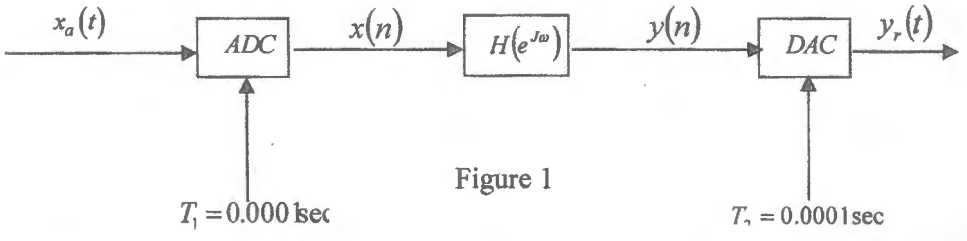


Figure 1

Contd...2

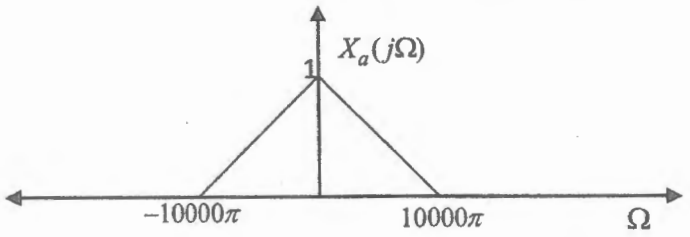


Figure 2

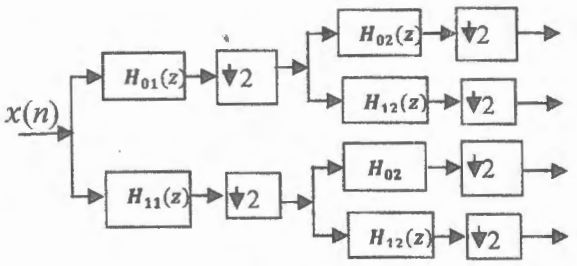
12. a) Explain the bilinear transformation method. [3]

b) Design a Chebyshev IIR digital low pass filter for the following Specifications: [7]
Pass band cutoff frequency: 400Hz; Stop band cutoff frequency: 600Hz
Pass band ripple: 1dB;Stop band ripple: 10dB
Assuming sampling frequency of 2000Hz. Use Bilinear transformation.

13. a) Obtain relation between the Fourier transform of the input and output of the down sampler. [4]

b) Design a two stage interpolator to increase the sampling rate from 600Hz to 9 KHz. [6]
The overall interpolator filter should satisfy the following specifications:
passband edge : 200Hz; stopband edge : 300Hz, passband ripple:1dB; stopband ripple:60dB.

14.



a) Obtain non-tree equivalent for the above tree structured QMF bank and relations between the analysis filters of the two structures. [4]

b) The analysis filters of a three channel QMF filter bank are [6]

$$H_0(z) = 1, H_1(z) = 2 + z^{-1} + z^{-5}, H_2(z) = 3 + z^{-1} + 2z^{-2}$$

i) Can you determine the FIR synthesis filters $G_0(z)$ and $G_1(z)$ so that the two channel QMF bank is an alias-free and perfect reconstruction system. If so find them.

ii) If not, find the set of stable IIR filters for an alias-free and perfect reconstruction system.

15. a) Obtain Daubechies wavelet filter coefficients for N=2 using coefficient domain solution. [7]

b) Consider a two channel perfect reconstruction biorthogonal filter bank with the analysis filters $h_0(n) = \{-1,2,6,2,-1\}/4\sqrt{2}$ and $h_1(n) = \{1,2,1\}/2\sqrt{2}$. Find the corresponding dual (synthesis) filters $\tilde{h}_0(n)$ and $\tilde{h}_1(n)$. [3]

16. a) Show that the frequency spectrum $X(e^{j\omega})$ of a discrete time signal x(n) is periodic with respect to ω with a period of 2π. [7]

b) Design a optimal FIR highpass filter of mength 3 to meet the following specifications: [3]
Passband edge frequency= $f_p = 1000\ Hz$;
Stopband edge frequency= $f_s = 750\ Hz$
Sampling frequency= $5000\ Hz$
Tolerance ratio= $(\delta_p/\delta_s) = 2$

17. Write short notes on any **two** of the following:

a) Bring out the advantages of Multirate Signal Processing. [5]

b) Obtain the conditions for alias free and perfect reconstruction of two channel QMF bank. [5]

c) Write short notes on wavelet reconstruction. [5]

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