USN

12EC123

M.Tech Degree Examination, June/July 2015

Modern DSP

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Consider the analog signal $x_a(t) = 3\cos 2000\pi t + 5\sin 6000\pi t + 10\cos 12000\,\pi t$. What is the Nyquist rate for this signal? If the signal is sampled at the rate of Fs = 5000, what is the Nyquist rate for the signal? If the signal is sampled at a rate of Fs = 5000 samples per second, what is the discrete time signal obtained after sampling. **(06 Marks)**

b. Find the DFT of a sequence

$$x(n) = \begin{cases} 1 & \text{for } \quad 0 \le n \le 2 \\ 0 & \text{otherwise} \end{cases} \text{ for N = 8.}$$

Plot $|x(k)|$ and $\angle x(k)$. **(08 Marks)**

c. Find the 4 point real sequence x(n) if its 4 – point DFT samples are x(0) = 6, x(1) = -2 + j2, x(2) = -2. Use DIF – FFT algorithm. **(06 Marks)**

2 a. Explain the steps involved for realization of FIR filter design. **(05 Marks)**

b. Compare FIR and IIR filters. **(05 Marks)**

c. Design an FIR digital filter to approximate an ideal low pass filter with pass band gain of unity, cut off frequency of 850 Hz and working at a sampling frequency of f_s = 5000Hz. Length of impulse response should be 5. Use rectangular window. **(10 Marks)**

3 a. Explain the approaches used in design of IIR digital filters. **(05 Marks)**

b. Explain the IIR filter designing using Impulse Invariance Technique. **(08 Marks)**

c. For the analog transfer function :

$H(s) = \dfrac{2}{(s+1)(s+2)}$ determine H(z) using impulse invariance method. Assume T = 1 sec. **(07 Marks)**

4 a. Explain Bilinear transformation technique. **(10 Marks)**

b. An IIR digital low pass filter is required to meet the following specifications :
Pass band ripple (or peak to peak ripple) ≤ 0.5 dB ; Pass band edge = 1.2 KHz ;
Stop band attenuation ≥ 40 db ; Stop band edge = 2.0KHz ; Sample rate : 8.0KHz.
Determine the required filter order for i) A digital butter worth filter ii) A digital Chebshev filter. **(10 Marks)**

5 a. List three basic operations which are required for resampling of a digitized signal. **(03 Marks)**

b. Consider a signal x[n] sampled at a frequency F_x = 10 KHz. Consider the following two cases : i) Resample the signal at a new sampling frequency F_y = 22KHz. Obtain the frequency spectrum of the resampled signal ii) Resample the same signal x[n] at a new sampling frequency F_y = 8KHz. Obtain the frequency spectrum of the resampled signal. Also comment on the loss of information in both the cases. Ref. Fig.Q5(b). **(07 Marks)**

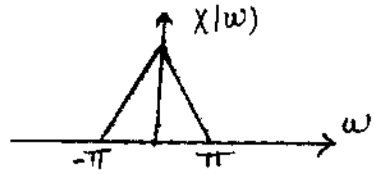
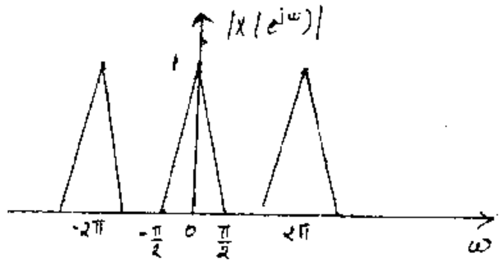


Fig.Q5(b)

c. Consider the spectrum of the input signal $x(e^{jw})$ with a band width of $\frac{-\pi}{2}$ to $\frac{+\pi}{2}$ as shown in fig. Q5(c). When the signal is downsampled by a factor D, sketch the spectrum of a downsampled signal for sampling rate reduction factor D = 3. **(06 Marks)**

Fig.Q5(c)



d. Determine the output y(n) in terms of input x(n) for the multirate system shown in fig. Q5(d). **(04 Marks)**

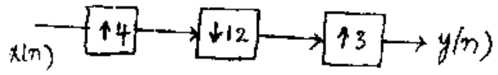
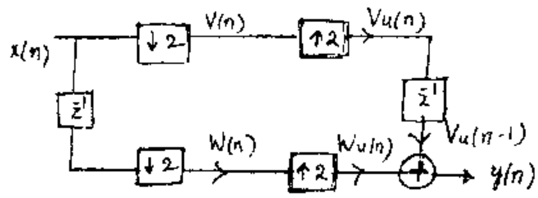


Fig.Q5(d)

6 a. Show that the interpolator is a linear system. **(04 Marks)**

b. For the multirate system shown in fig. Q6(b), determine y(n) as a function of x(n). **(06 Marks)**

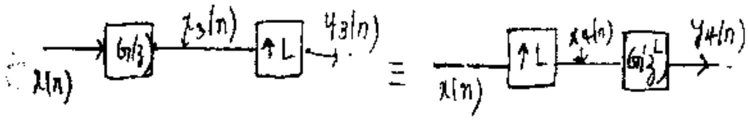
Fig.Q6(b)



c. Explain Digital Filter banks using analysis and Synthesis Filter banks representation. **(06 Marks)**

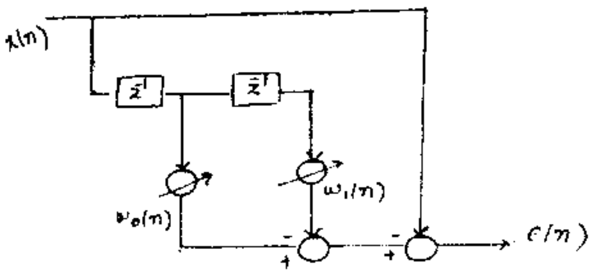
d. Prove the following identity. **(04 Marks)**

Fig.Q6(d)



7 a. For the adaptive predictor shown in fig. Q7(a), let $x(n) = \sin\frac{\pi n}{4}$. Write explicit weight update equations using the LMS algorithm starting from zero initial weights. Compute the next five weight values. **(14 Marks)**

Fig.Q7(a)



b. Consider the sequence x(n) = {2, 6, 4, 8}

$H_1(z) = \frac{1}{2}(1+z^{-1})$, $G_1(z) = 1 + z^{-1}$.

$H_2(z) = \frac{1}{2}(1- z^{-1})$, $G_2(z) = -1 + z^{-1}$. Referring to fig. Q7(b), obtain reconstruction of the signal. **(06 Marks)**

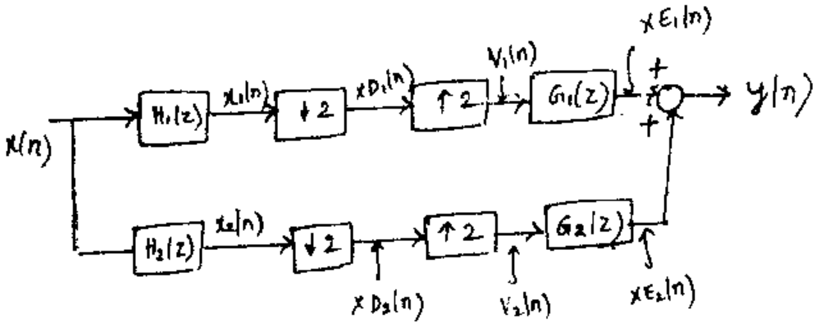


Fig.Q7(b)

8 a. Comment on the least square criteria and the forgetting factor for a recursive RLS estimation. **(06 Marks)**

b. Write explicit weight update equations using the RLS algorithm with $\delta = 0.1$ and forgetting factor $\lambda = 1$. Starting from zero initial weight. Compute the first weight update. Ref. Fig. Q8(b). **(14 Marks)**

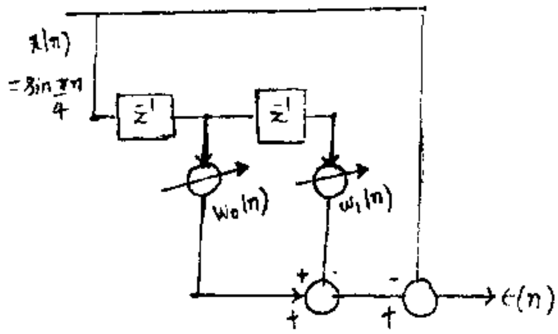


Fig.Q8(b)

*****