Total No. of Questions : 8]

SEAT No. :

P2163

[Total No. of Pages : 4

[5059]-628

B.E.(E&Tc)

MULTIRATE AND ADAPTIVE SIGNAL PROCESSING

(2012 Pattern)(Elective-II)

Time :2½Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) *Neat diagrams must be drawn wherever necessary.*
2) *Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
3) *Assume suitable data, if necessary.*

Q1) a) Verify Parsevals theorem for $x(t) = e^{-6t}.\ u(t)$ **[6]**

b) For a given signal, x(t)

$x(t) = 1+t \quad -1 \leq t \leq 0$

$\quad = 1-t \quad 0 \leq t \leq 1$

find- i) average time **[2]**

ii) energy in x(t) **[2]**

iii) variance in time domain **[4]**

iv) Energy in $\frac{d}{dt}x(t)$ **[2]**

v) Variance in frequency domain **[4]**

OR

Q2) a) Design at a block diagram level, a two stage decimator that down samples an audio signal by a factor 30 and satisfies the following specifications-

i) ilp sampling frequency fs $\rightarrow$ 240 KHz

ii) Highest frequency fo interest in the $\rightarrow$ 3.4KHz data

iii) Pass band ripple, $\delta_p \rightarrow 0.05$

iv) Stop band ripple, $\delta_s \rightarrow 0.01$

filter length, $N=\frac{-10\log(\delta_p\delta_s)-13}{14.6\ \Delta f}+1$

WhereΔf= normalized transistion width assume decimation factors of 10&3 for stages 1&2 respectively. **[16]**

b) For the decimator in part a, calculate the total number of multiplications per second (MPS) and the total storage requirements(TSR) **[4]**

P.T.O.

Q3) a) Derive the conditions of alias cancellation for a Harr 2 band filter bank structure **[8]**

b) Find out the magnitude and phase response of the systems represented by following i/p o/p relations

i) $Y(n) = \frac{1}{2}[x(n) + x(n-1)]$ **[5]**

ii) $Y(n) = \frac{1}{2}[x(n) - x(n-1)]$ **[5]**

OR

Q4) For the signal, y(t) shown in fig-1

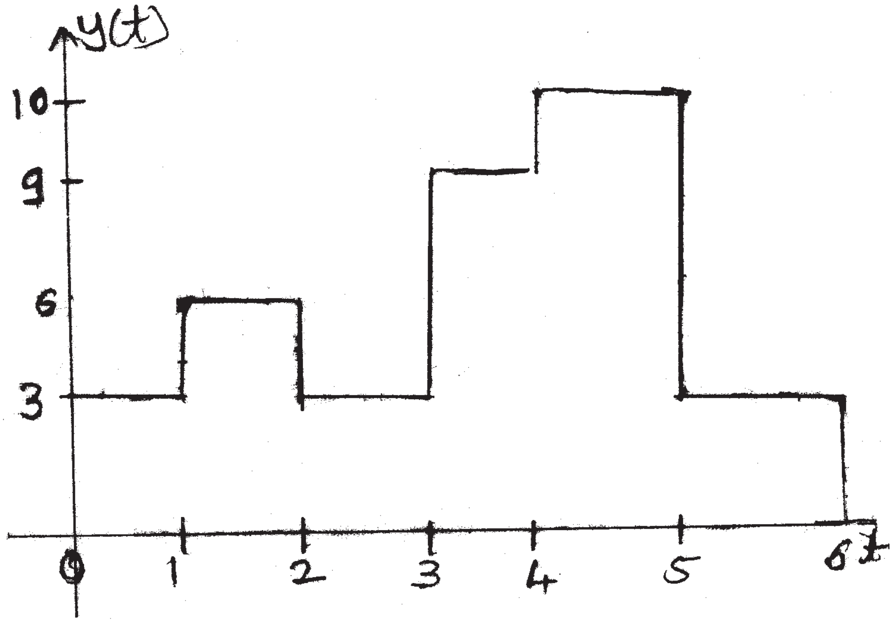

fig (1)

a) State which V subspace Y(t) belongs to and why **[2]**

b) Calculate the piecewise constants such that y(t) belongs to V-1 & W-1 subspace **[6]**

c) Using Harr $\phi\left(\frac{t}{2}\right)$, plot projections and span of y(t) on V-1 and using Harr $\psi\left(\frac{t}{2}\right)$,plot projections & span as y(t) on W-1 **[4]**

d) Reconstruct the original signal. Show that **[6]**

$V_0 = V_{-1} \oplus W_{-1}$

Q5) For an adaptive filter, inputs $X_1 = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$ and $X_2 = \begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}$ have target(desired) values, $Y_1 = -1$ $Y_2 = 1$ respectively.

The convergence factor $\mu=0.3$. The initial weights of the filter are W=[0 0 0].

The filter is trained using LMS algorithm, for four iterations. The inputs applied to the filters follow the sequence, $X_1, X_2, X_1 \& X_2$.

Find-

a) Find the weight vector at the end of each iteration **[8]**

b) Also find the error at the end of each iteration **[4]**

c) Find mean square error at the end of second and fourth iteration **[4]**

OR

Q6) a) Prove that cost function of an adaptive filter is given by

$$J(W) = E\left[d^2(n)\right] - 2W^T P_{dx} + W^T R_x W$$

Where d(n) is the desired signal

P_{dx} is the cross correlation vector

R_x is the auto correlation matrix

W is the weight vector. **[8]**

b) For an adaptive filter is

$$R_X = \begin{bmatrix} 1 & 0.5 \\ 0.5 & 1 \end{bmatrix} P_{dx} = \begin{bmatrix} -1 & 1 \end{bmatrix}^T \; \& \; E\left[d^2(n)\right] = 4$$

Find-

i) Optimum weight vector by solving wiener hoff equation **[6]**

ii) minimum value of the cost function **[2]**

Q7) $X[n]=\{40, 10, 36, 4, 48, 2, 10, 0\} \in V_3$

a) Show smoothing effect **[8]**

b) Reconstruct after suppressing coefficients in Wj subspaces **[8]**

OR

Q8) Write a notes on: **[16]**

a) Wavelet lifting scheme

b) Any one application of Adaptive filters

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