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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, APRIL/MAY 2018

Branch: Electronics and Communication Engineering

Stream: Signal Processing

Course Code & Name: 01EC6306 Multirate Systems and Wavelets

Answer *any two full* questions from *each* part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

PART A

1. Analyze the structure of Fig. 1. Show that the system is time invariant and determine the transfer functions from each input to each output. 9

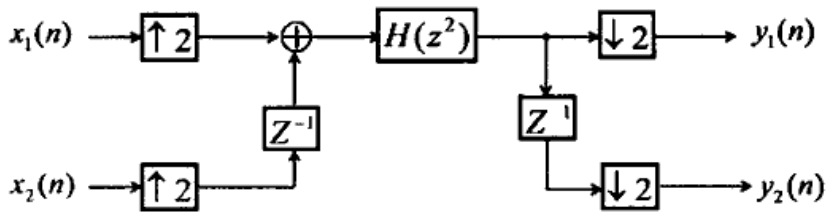

Fig. 1

2. Explain two-channel Quadrature Mirror Filter (QMF) bank. What are the common errors created in the QMF bank? Derive the conditions for an alias free response for a two-channel QMF bank. 9

3. a. Derive the frequency domain representation of an M-fold down sampler and an L-fold up-sampler. 4

   b. The analysis filters of a three-channel QMF bank are given by 5

$$[H_0(z)\ H_1(z)\ H_2(z)] = [z^{-2}\ z^{-1}\ 1]\begin{bmatrix} 2 & 4 & 1 \\ -1 & 4 & -2 \\ 2 & -1 & 2 \end{bmatrix}$$

   Determine the synthesis filters for implementing a perfect reconstruction filter bank.

PART B

4. a. State Heisenberg's uncertainty principle. 2

b. Calculate 2-level Haar Wavelet decomposition of the following sequence [4, 2, 6, -2, 4, 6, 2, 2]. Now retain all coefficients whose magnitude is greater than one and do inverse decomposition to reconstruct the signal. Calculate mean square error. 7

5. For 6-tap Daubechies wavelet system, derive the various equations that must be satisfied by considering the different restrictions on filter coefficients. 9

6. Consider f(t) to be a triangular waveform as defined below. Express f(t) in terms of f(2t) and its translates. 9

$$f(t)=\begin{cases} t & ; \quad 0 \le t \le 1 \\ 2-t & ; \quad 1 \le t \le 2 \\ 0 & ; \quad \textit{Otherwise} \end{cases}$$

PART C

7. Derive the Mallat Filterbank structure (Analysis & Synthesis) for a Biorthogonal Wavelet System starting from the basic two scale equations. 12

8. a. State the relationship between different functional spaces in a biorthogonal wavelet system. What is the motivation for designing biorthogonal systems? 4

b. Show that the vectors p_1 and p_2 along with the vectors d_1 and d_2 form a biorthogonal system of vectors. 2

$$p_1 = (0,1), \qquad p_2 = \left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right), d_1 = \left(1, \frac{-\sqrt{3}}{2}\right), d_2 = \left(0, \frac{2}{\sqrt{3}}\right)$$

c. Draw the Haar wavelet packet basis for three levels of decomposition. 6

9. For the seven-level decomposition shown below, 12

34	8	12	12
-8	8	5	2
2	-2	6	-3
-12	-12	0	0

Find the bit stream or labels generated by the Embedded Zerotree Wavelet (EZW) coder, after three steps of multiple pass procedure.