USN | | | | | | | | | | |

08EC053

M.Tech. Degree Examination, May/June 2010
Multirate Systems and Filter Banks

Time: 3 hrs. Max. Marks:100

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

1 a. Explain the time domain operation of a M = 2 decimator. Derive the general input-output Z-transform domain and frequency domain relations for M fold decimator. **(10 Marks)**

b. Write polyphase type – I components for M = 2 for the following:

i) $H(z) = 1 + 2z^{-1} + 3z^{-2} + 4z^{-3}$ ii) $H(z) = \frac{(a + z^{-1})}{(1 + az^{-1})}$ **(10 Marks)**

2 a. With a neat block diagram, explain the digital / analog hybrid QMF bank in digital audio. **(08 Marks)**

b. Consider a sequence x(n) whose spectrum $X(e^{jw})$ is as shown in Fig.Q2(b). Let y(n) = x(2n) and y(n) = x(n/5).

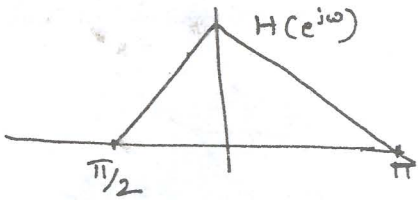

Fig.Q2(b)

Write relevant expressions & graphically explain how you recover x(n) from y(n). **(12 Marks)**

3 a. Mention the nobel identities for multirate system and prove them. **(10 Marks)**

b. Draw the block diagram of the synthesis bank of 3 level tree structural QMF bank and its equivalent 4 channel system. Also, explain multi-resolution analysis algorithm. **(10 Marks)**

4 a. Explain strictly complementary functions and power complementary functions. **(06 Marks)**

b. Discuss multistage design of decimator, with the help of the given stage system, Fig.Q4(b). Specification for the decimation filter H(z) are F_p = 180 Hz, F_s = 200 Hz, δ_p = 0.002 , δ_s = 0.001 **(06 Marks)**

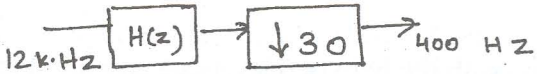

Fig.Q4(b)

c. Consider a 2 channel maximally decimated filter bank, with analysis filter $H_0(z) = 1 + z^{-1}$ and $H_1(z) = 1 - z^{-1}$.

i) Obtain the polyphase matrix E(z)
ii) Is E(z) paraunitary?
iii) Obtain $F_0(z)$, $F_1(z)$ synthesis filter for PR **(08 Marks)**

5 a. Consider the uniform DFT analysis bank with M = 4. Assume
$E_0(z) = 1 + z^{-1}$, $E_1(z) = 1 + 2z^{-1}$, $E_2(z) = 2 + z^{-2}$, $E_3(z) = 0.5 + z^{-1}$
Determine $H_k(z)$ for $0 < k < 3$. **(08 Marks)**

b. Explain alias free 2 channel QMF system. Obtain the expression for the reconstructed signal amplitude and phase distortion. **(12 Marks)**

6 a. Explain M = 3 transmultiplexer multirate building block and demonstrate the FDM circuit, with a neat frequency spectrum. How do you design filters for perfect reconstruction transmultiplexers? **(10 Marks)**

b. For higher order perfect reconstruction system for J = 1, $R_0 = \begin{bmatrix} 1 & 3 & 1 \\ 1 & 0 & 0 \\ 3 & 1 & 0 \end{bmatrix}$, $R_1 = R_0^T$

i) Compute analysis and synthesis filter.
ii) Draw the corresponding analysis and synthesis bank. **(10 Marks)**

7 a. What are the necessary and sufficient conditions for perfect reconstruction in terms of E(z) and R(z)? **(05 Marks)**

b. Consider 2 paraunitary systems shown in Fig.Q7(b)(i) & (ii):

i) Obtain the respective transfer function.
ii) Obtain cascaded structure $H_N(z) = R_1 \wedge (z)\, R_0$ with $\theta_0 = \theta_1 = \pi/4$.
iii) Show that the obtained transfer function of the cascaded system is also paraunitary. **(08 Marks)**

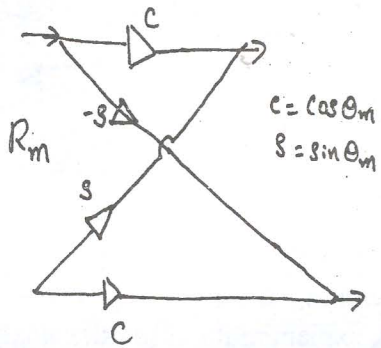

Fig.Q7(b)(i)

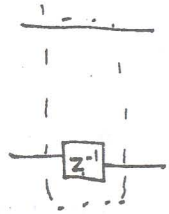

Fig.Q7(b) (ii)

c. Describe the cosine modulated perfect reconstruction system. **(07 Marks)**

8 a. Explain STFT using signals x(n) and window v(n). Explain the trade off between time localization and frequency resolution in STFT. **(10 Marks)**

b. Explain the properties of wavelet functions. Obtain m channel non-uniform bandwidth wavelet filter bank, with the help of 3 level tree structural QMF bank. **(10 Marks)**

* * * * *