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NPTEL

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Courses » Mathematical Methods and Techniques in Signal Processing

Announcements Course Ask a Question Progress FAQ

Week 8 - Multirate Systems - IV

Register for Certification exam

Course outline

Assignment 08

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-03-27, 23:59 IST.

Instructions:

1. **Attempt all questions.**
2. **Submission deadline**: 27th March 2019 23:59 IST
3. **Solutions to be posted**: 28th March 2019
4. Older browsers might show **unnecessary vertical bars** at the end of math equations

1) Consider the polyphase representation of a 16-channel filter bank. Suppose the product $E(z)R(z)$ is an identity matrix, we get the reconstructed output after a delay of x units. The value of x is

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Numeric) 15

1 point

2) Consider a two channel filter bank with quadrature mirror property satisfying alias cancellation conditions. Let $H_0(z)$ and $H_1(z)$ be the analysis filters and $F_0(z)$ and $F_1(z)$ be the synthesis filters. Let $F_0(z) = H_0(z)$. For which of the following matrices is the vector $[H_0(z)\ H_1(z)\ F_0(z)\ F_1(z)]^{\mathrm{T}}$ an eigenvector with eigenvalue 1? ***1.5 points***

- [ ] $\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{bmatrix}$
- [ ] $\begin{bmatrix} 1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 \end{bmatrix}$
- [ ] $\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & 0 & 0 \\ \ldots \end{bmatrix}$

- Perfect reconstruction of signals
- Nyquist and half band filters
- Special filter banks for perfect reconstruction
- Quiz : Assignment 08
- Assignment 8 - Solutions

Week 9 - Wavelets - I

Week 10 - Wavelets - II and Continuity of Functions

Week 11 - Fourier Series - I

Week 12 - Fourier Series - II and KL Transform

Interaction Session

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{bmatrix}\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{bmatrix}$$

3) Consider the following M-channel delay filter bank. Let $H_i(z)$ and $F_i(z)$ denote the analysis and the synthesis filter in the $(i+1)^{\text{th}}$ branch (where $i \in \{0, 1, \ldots, M-1\}$) respectively. ***2 points***

Which of the following are the expressions for $H_i(z)$ and $F_i(z)$?

- $H_i(z) = z^{-i}$ and $F_i(z) = z^{-i}$
- $H_i(z) = z^{-(i-1)}$ and $F_i(z) = z^{-(i-1)}$
- $H_i(z) = z^{-i}$ and $F_i(z) = z^{(i-M+1)}$
- $H_i(z) = z^{-(i-1)}$ and $F_i(z) = z^{(i-M)}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$H_i(z) = z^{-i}$ and $F_i(z) = z^{(i-M+1)}$

4) Which of the following are half band filters? ***2 points***

- $H(z) = 7 + 4z^{-1} - z^{-5}$

$H(z) = 3 + z^{-8}$

$H(z) = 2 + z^{2} + z^{-3}$

$H(z) = 2 + z^{-1} + z^{3}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$H(z) = 7 + 4z^{-1} - z^{-5}$
$H(z) = 2 + z^{-1} + z^{3}$

5) Which of the following filters are minimum phase filters? ***2 points***

$H_1(z) = \frac{3 - z^{-1}}{2 - 5z^{-1} + 2z^{-2}}$

$H_2(z) = \frac{6 - 7z^{-1} + 2z^{-2}}{3 + 2z^{-1}}$

$H_3(z) = \frac{1 - 2z^{-1}}{5 - z^{-1}}$

$H_4(z) = \frac{3 - 7z^{-1} + 2z^{-2}}{1 - 2z^{-1}}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$H_2(z) = \frac{6 - 7z^{-1} + 2z^{-2}}{3 + 2z^{-1}}$
$H_4(z) = \frac{3 - 7z^{-1} + 2z^{-2}}{1 - 2z^{-1}}$

6) ***2 points***

(True/False): As $P(z) = I$ ensures perfect reconstruction, for $E(z) = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 0 \\ -3z^{-1} & 2 & 1 \end{bmatrix}$, one can obtain stable synthesis filters using $R(z) = E(z)^{-1}$ which yield perfect reconstruction.

True
False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

7) For the filter bank in Question 3, what is $A_l(z)$? ***2 points***

$A_l(z) = 0$

$A_l(z) = z^{-(M-1)}\delta_l$

$A_l(z) = z^{-M}$

$A_l(z) = \frac{z^{-(M-1)}}{M}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$A_l(z) = z^{-(M-1)}\delta_l$

8) (True/False) In Question 3, $x[n]$ can be reconstructed perfectly from the filter bank output $\hat{x}[n]$ by using delay elements. ***2 points***

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

9) Consider the Haar wavelet decomposition and reconstruction upto second scale as non-uniform filter bank (i.e., decimation and upsampling rates are non-uniform across different channels). The analysis filters look like the following on simplification: ***2.5 points***

The analysis filters $H_i(z)$ for this filter bank are given as follows:

$H_2(z) = \frac{1+z^{-1}+z^{-2}+z^{-3}}{2}$
$H_1(z) = \frac{1+z^{-1}-z^{-2}-z^{-3}}{2}$
$H_0(z) = \frac{1-z^{-1}}{\sqrt{2}}$

Test which of the special properties given below are satisfied by the analysis filter bank.

- Strictly complementary
- Power complementary
- All pass complementary
- None of the above

No, the answer is incorrect.
Score: 0

Accepted Answers:
None of the above

10)Consider a 3 channel filter bank with analysis filters ***3 points***
$H_0(z) = 1, H_1(z) = 6 + z^{-1} + 6z^{-5}$ and $H_2(z) = 2 + z^{-1} + 2z^{-2}$ and synthesis filters $F_0(z) = -1 - z^{-1} + 2z^{-2} + 4z^{-4} - 5z^{-5}$, $F_1(z) = -1 + z^{-1}$ and $F_2(z) = 1 - z^{-4}$. Which of these following choices is $E(z), R(z)$ and do these form Nyquist M filters?

- $E(z) = \begin{bmatrix} 1 & 6 & 2 \\ 0 & 1 & 1 \\ 0 & 6z^{-3} & 2 \end{bmatrix}, R(z) = \begin{bmatrix} 2-5z^{-3} & -1+4z^{-3} & -1 \\ 0 & 1 & -1 \\ 0 & -z^{-3} & 1 \end{bmatrix}$ and they are Nyquist M filte
- $E(z) = \begin{bmatrix} 1 & 0 & 0 \\ 6 & 1 & 6z^{-1} \\ 2 & 1 & 2 \end{bmatrix}, R(z) = \begin{bmatrix} 2-5z^{-1} & 0 & 0 \\ -1+4z^{-1} & 1 & -z^{-1} \\ -1 & -1 & 1 \end{bmatrix}$ and they are not Nyquist M filt
- $E(z) = \begin{bmatrix} 1 & 0 & 0 \\ 6 & 1 & 6z^{-1} \\ 2 & 1 & 2 \end{bmatrix}, R(z) = \begin{bmatrix} -1 & -1+4z^{-1} & 2-5z^{-1} \\ -1 & 1 & 0 \\ 1 & -z^{-1} & 0 \end{bmatrix}$ and they are not Nyquist M
- $E(z) = \begin{bmatrix} 1 & 6 & 2 \\ 0 & 1 & 1 \\ 0 & 6z^{-1} & 2 \end{bmatrix}, R(z) = \begin{bmatrix} -1 & -1+4z^{-1} & 2-5z^{-1} \\ -1 & 1 & 0 \\ 1 & -z^{-1} & 0 \end{bmatrix}$ and they are Nyquist M filte

No, the answer is incorrect.
Score: 0

Accepted Answers:
$E(z) = \begin{bmatrix} 1 & 0 & 0 \\ 6 & 1 & 6z^{-1} \\ 2 & 1 & 2 \end{bmatrix}, R(z) = \begin{bmatrix} 2-5z^{-1} & 0 & 0 \\ -1+4z^{-1} & 1 & -z^{-1} \\ -1 & -1 & 1 \end{bmatrix}$ and they are not Nyquist M filter

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