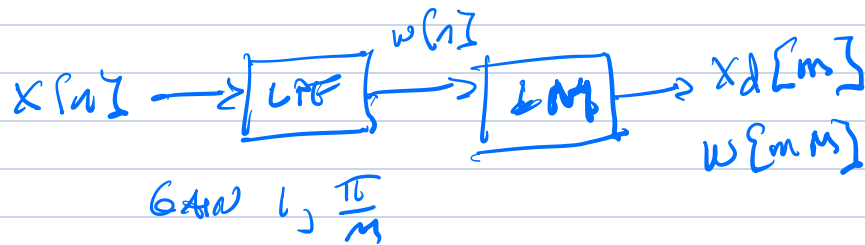


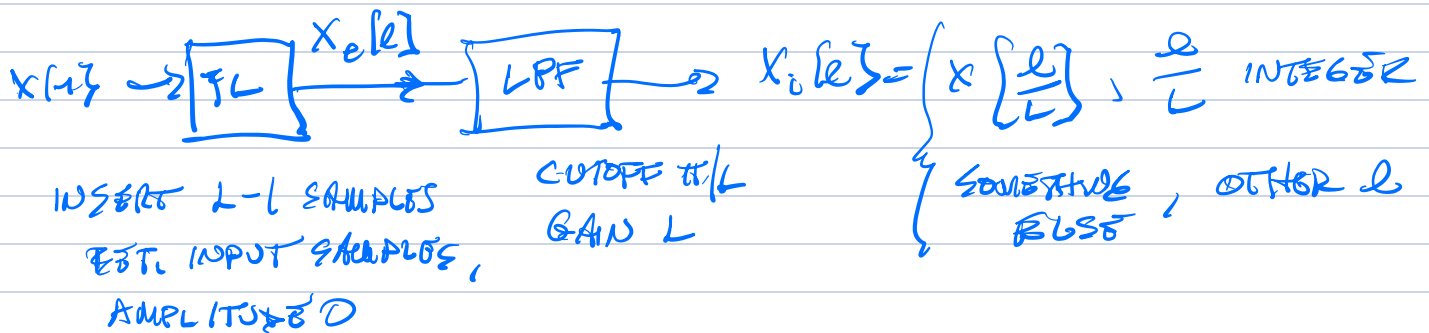
9/9/24 EFFICIENT DECIMATION + INTERPOLATION

(L40 3.3, NOTES 2.1-2.2)

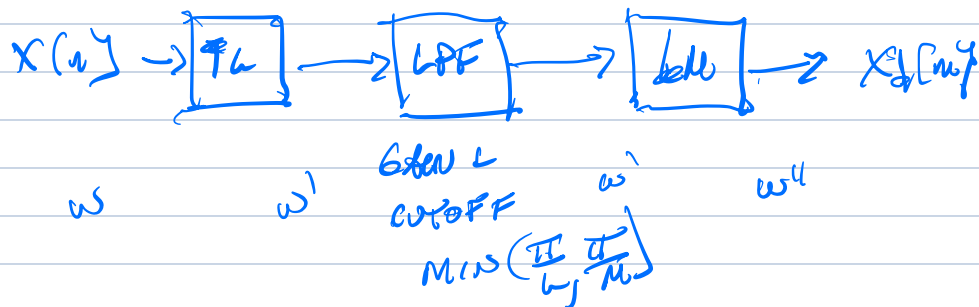
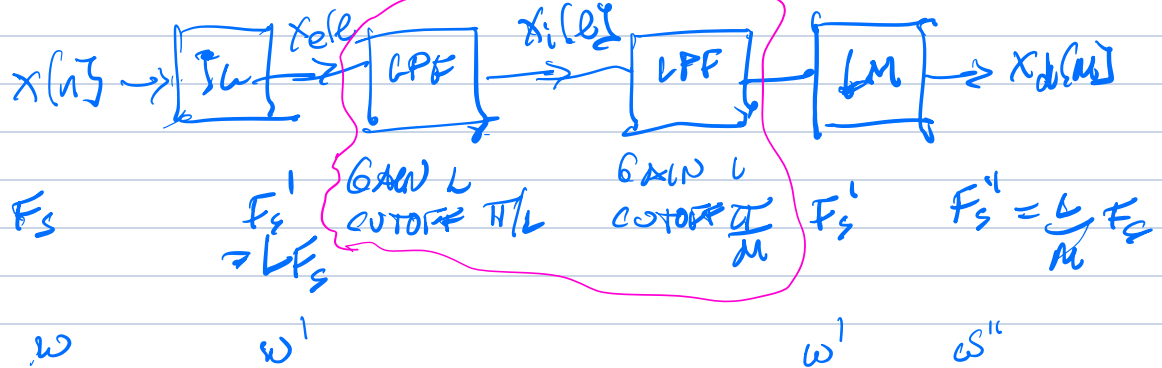
DECIMATION



INTERPOLATION

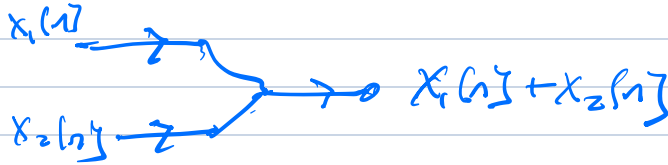


CHANGE OF SAMPLING RATE BY L/M



REVIEW OF SIGNAL FLOWGRAPH NOTATION (OSYP CHAP 6)

ADDITION



MULT BY
CONST



UNIT
DELAY



$$x[n] \rightarrow [h[n]] \rightarrow y[n]$$

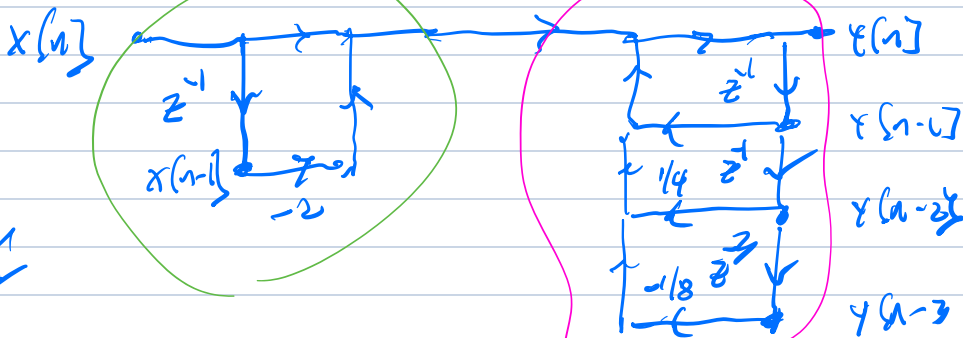
$$y[n] = x[n] * h[n]$$

$$Y(z) = X(z) \cdot H(z)$$

$$H(z) = \frac{Y(z)}{X(z)}$$

EX. LSI FILTERING

$$y[n] = y[n-1] + \frac{1}{4} y[n-2] - \frac{1}{8} y[n-3] + x[n] - 2x[n-1]$$



DF-I

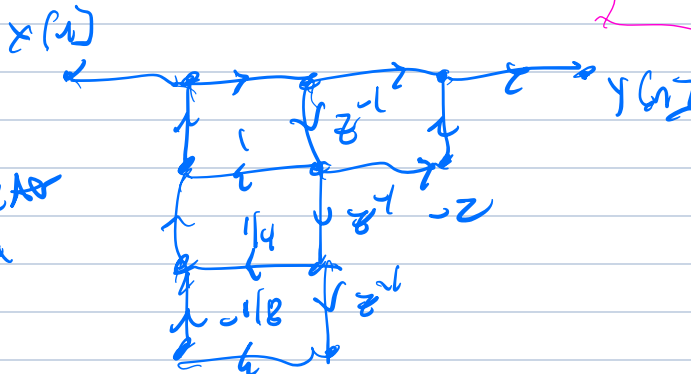
$$Y(z) = Y(z) \left(z^{-1} + \frac{1}{4} z^{-2} - \frac{1}{8} z^{-3} \right) + X(z) (1 - 2z^{-1})$$

$$Y(z) \left(1 - z^{-1} - \frac{1}{4} z^{-2} + \frac{1}{8} z^{-3} \right) = X(z) (1 - 2z^{-1})$$

$$H(z) = \frac{Y(z)}{X(z)} =$$

$$\frac{1 - 2z^{-1}}{1 - z^{-1} - \frac{1}{4} z^{-2} + \frac{1}{8} z^{-3}}$$

DF-II



"CANONICAL
FORM"

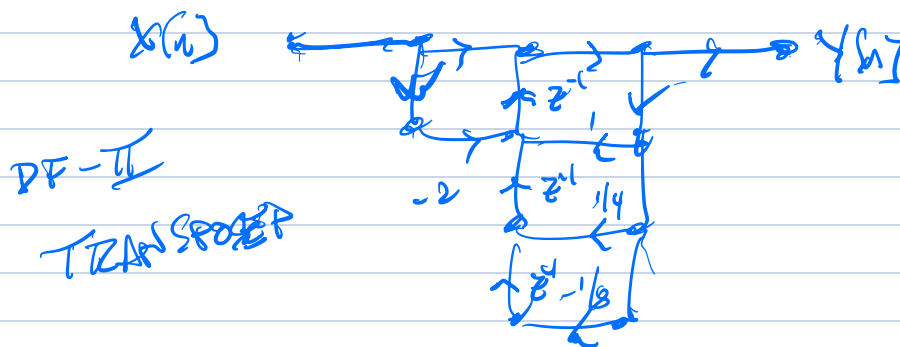
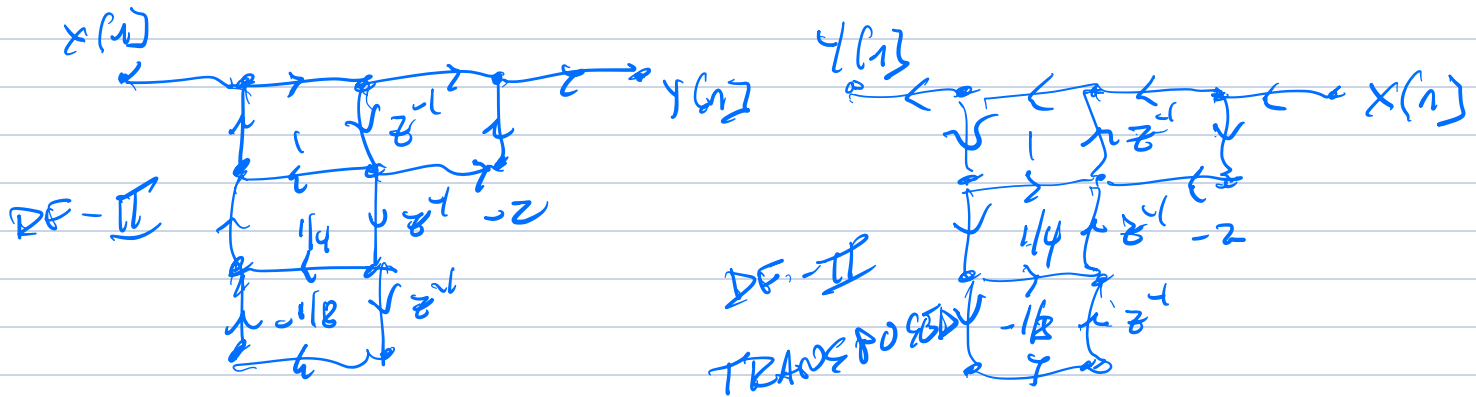
TRANSPPOSED FORM (S. J. MASON)

6WEP SIGNAL FLOW DIAGRAM..

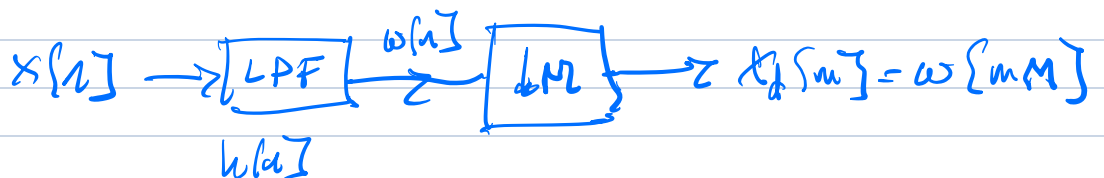
IF WB: 1. REVERSE ARROWS

2. INTERCHANGE INPUT + OUTPUT

⇒ FINAL RESULT IS THE SAME!

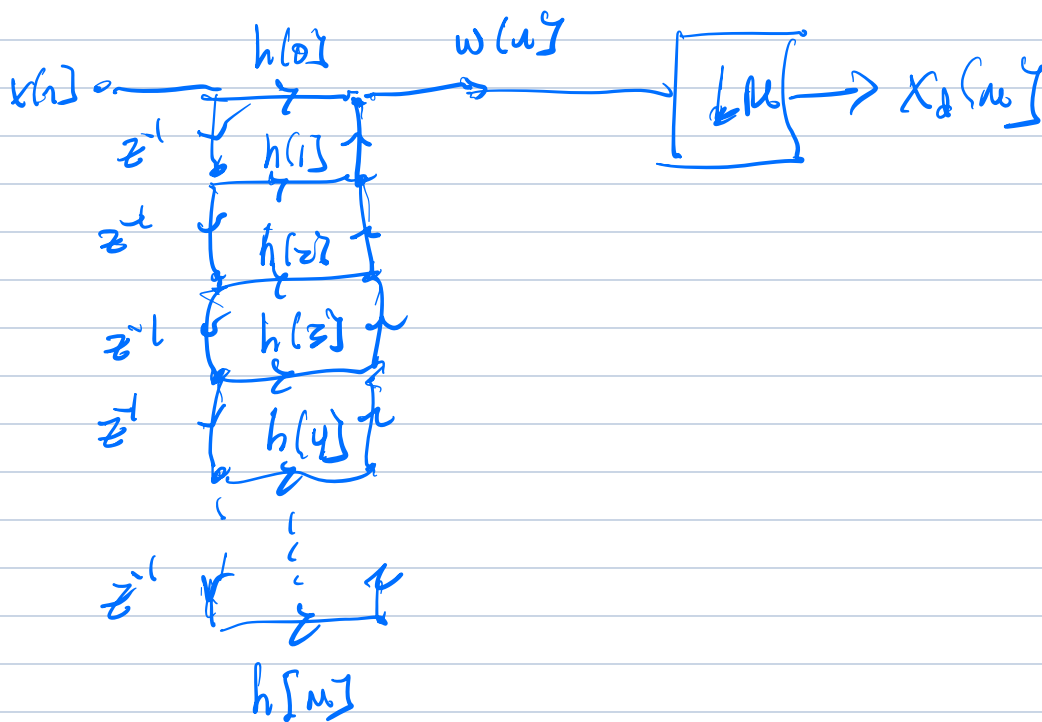


EFFICIENT STRUCTURES FOR DECIMATION



FIR REALIZATION

$$H(z) = \sum_{l=0}^M h[l] z^{-l} ; y[n] = \sum_{l=0}^M h[l] x[n-l]$$



INTERCHANGE OF DOWN SAMPLING WITH
OTHER OPERATIONS

ADDITION $x_1[n] = 0, 1, 2, 3, 4, 5, 6, 7$

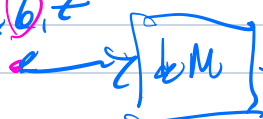
let $M=3$



$0, 3, 6, 9, 12, 15, 18$

$x_2[n] = 0, 2, 4, 6, 8, 10$

$x_1[n] = 0, 1, 2, 3, 4, 5, 6, 7$



$0, 9, 18$

$x_2[n] = 0, 2, 4, 6, 8, 10$



OUTPUT THE SAME

MULT

$x[n] = 0, 1, 2, 3, 4, 5, 6, 7, \dots$



$0, 3, 6, 9, \dots$

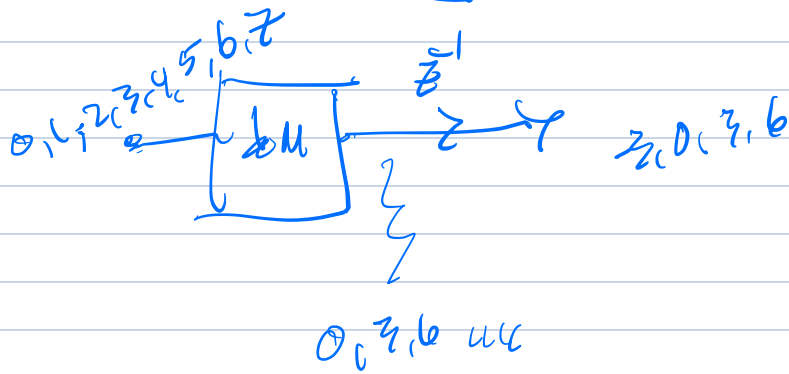
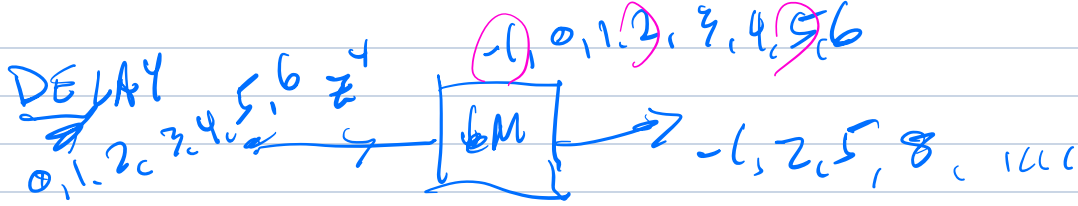
$x[n]$



$x_d[n]$

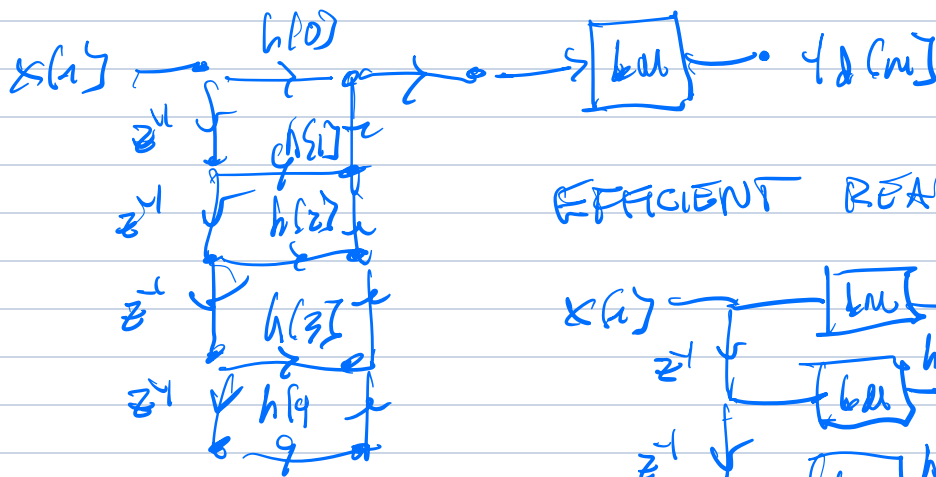
$0, 3, 6, 9, \dots$

OUTPUT
THE SAME

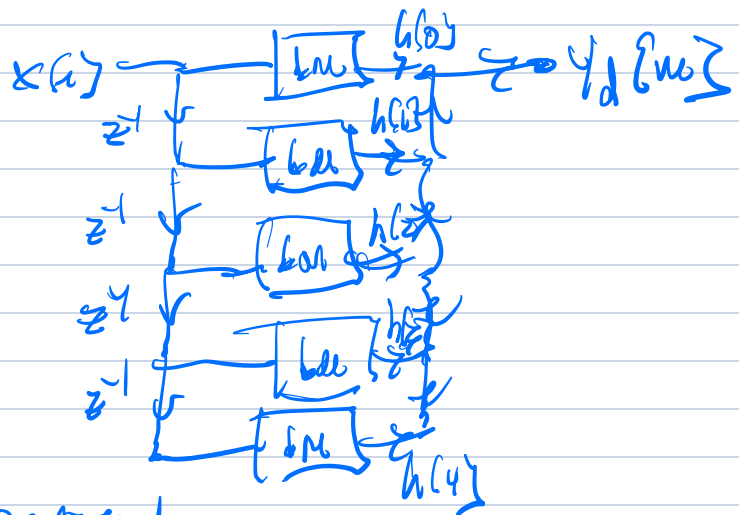


OUTPUTS
NOT THE
SAME

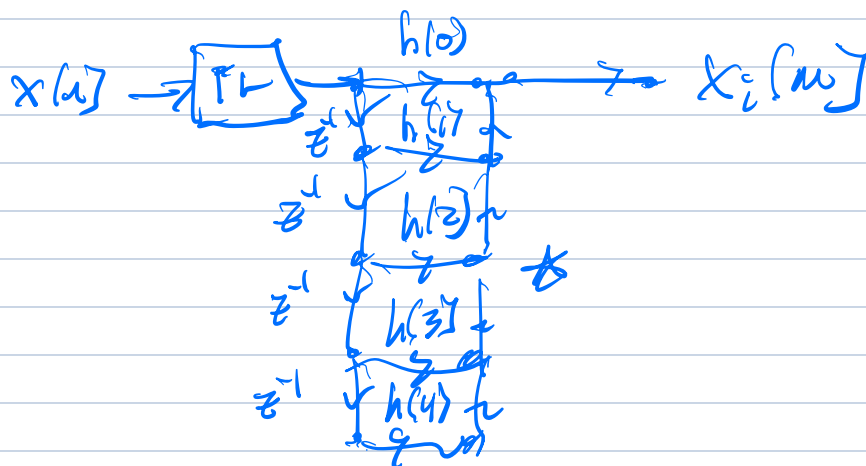
EFFICIENT DECIMATION



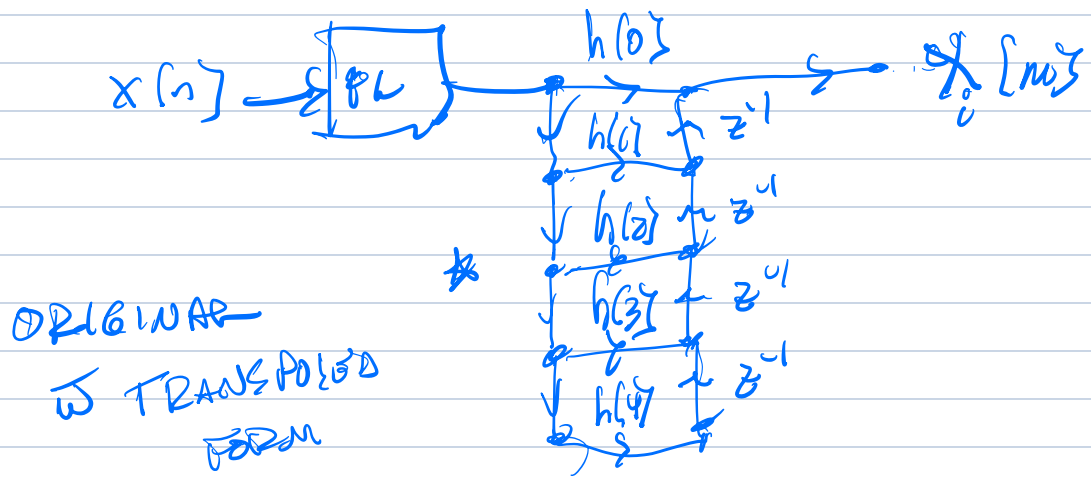
EFFICIENT REALIZATION



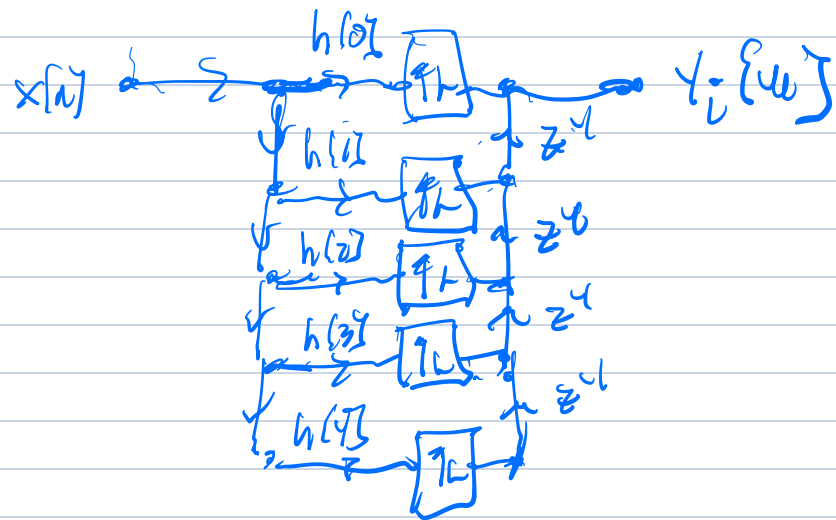
EFFICIENT INTERPOLATION



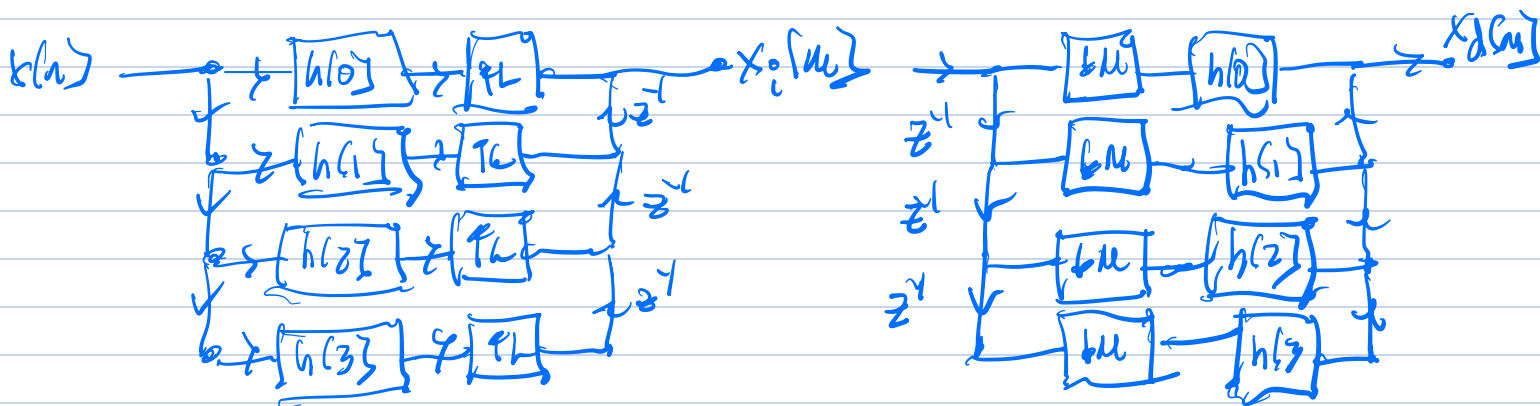
USING TRANSPOSED FORM OF FILTER



EFFICIENT STRUCTURE



COMPARISON OF UPSAMPLING + DOWNSAMPLING STRUCTURES



UPSAMPLING BY L

DOWNSAMPLING BY M

UPSAMPLING + DOWNSAMPLING ARE TRANSPOSE OF EACH OTHER.

MATHEMATICAL DESCRIPTION OF UP SAMPLING

