Realization of Digital ~~…~~ filters.

05/10/16.

Difference equation specifies actual operations that are performed by digital system on input data in time domain.

<u>Advantages</u> of representing digital filters in Block dia

→ easy to analyse I/O relationship

→ easy to determine hardware requirements

→ easy to develop block dia from transfer function.

FIR filter structures

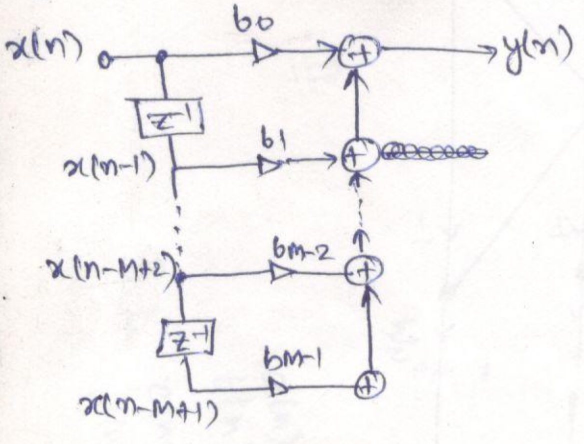
$$H(Z) = \sum_{K=0}^{M-1} b_K Z^{-K}$$

$$y(n) = b_0 x(n) + b_1 x(n-1) + \dots + b_{M-1} x(n-M+1)$$

length of filter = M = no. of coeff.

Order = M-1.

I. Direct-Form



D.F structure of (M-1)th order FIR filter requires.

- M-1 memory locations to store M-1 previous I/P samples.
- M memory locations to store M coeffients (b).
- M multipliers
- M-1 additions.

III. Polyphase structure

$$H(Z) = \sum_{K=0}^{M-1} b_K Z^{-K} = \sum_{K=0}^{M-1} h(K) Z^{-K}.$$

$$= \sum_{K=0}^{M-1} h(2K) Z^{-2K} + \sum_{K=0}^{M-1} h(2K+1) Z^{-(2K+1)}$$

→ separating odd & even indexes.

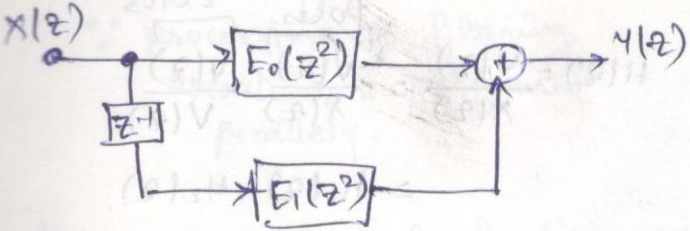
$$= \sum_{K=0}^{M-1} h(2K) Z^{-2K} + Z^{-1} \sum_{K=0}^{M-1} h(2K+1) Z^{-(2K)}$$

let $E_0(Z) = \sum_{K=0}^{M-1} h(2K) Z^{-K}$, $E_1(Z) = \sum_{K=0}^{M-1} h(2K+1) Z^{-K}$

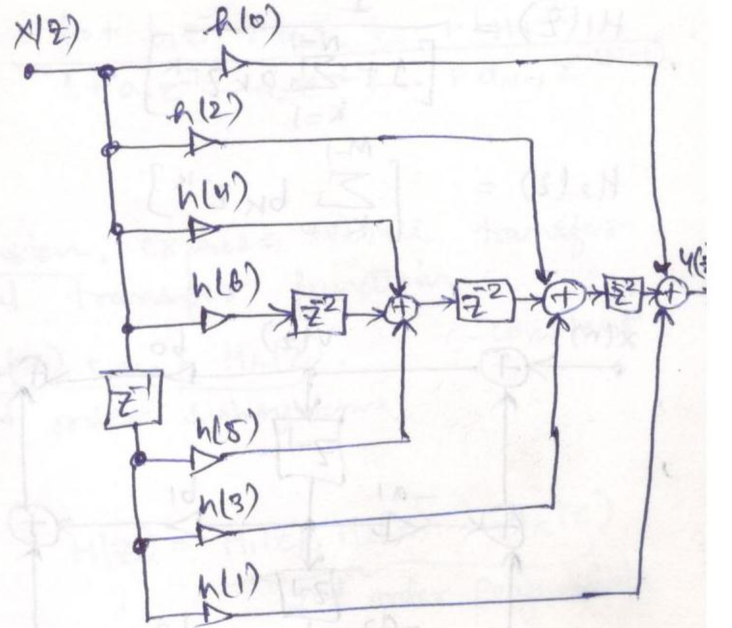
$$\Rightarrow H(Z) = E_0(Z^2) + Z^{-1} E_1(Z^2).$$

Ex: For length = 7.

$$H(z) = \left[h(0) + h(2)z^{-2} + h(4)z^{-4} + h(6)z^{-6}\right] + z^{-1}\left[h(1) + h(3)z^{-2} + h(5)z^{-4}\right].$$



Polyphase struct. of FIR filter.



For M=7.

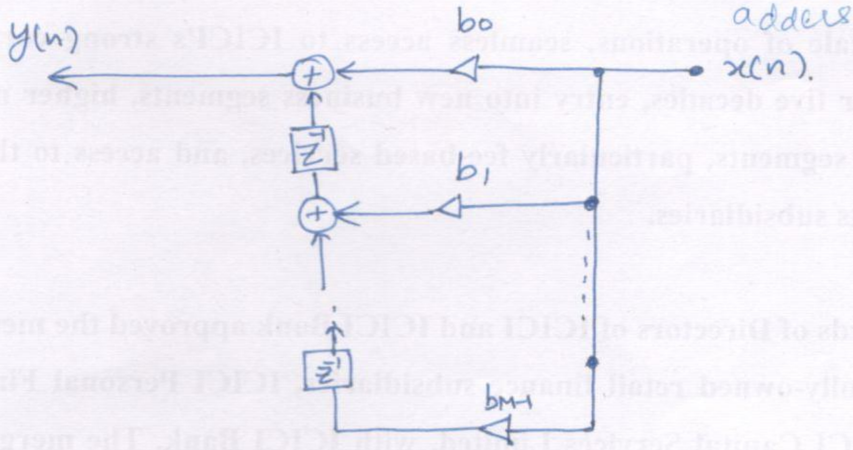
IIR filter structures.

$$\sum^{M-1} b_k z^{-k}$$

FIR

II Transposed structure (equivalent to direct form)

: → interchange i/p & o/p nodes
→ Reverse all paths.
→ Replace pick-off nodes by adders & vice versa.



IV Cascade form structure.

$$H(z) = H_1(z) \cdot H_2(z) \cdot H_3(z) \cdots H_k(z).$$

$$H_k(z) = b_{k0} + b_{k1} z^{-1} + b_{k2} z^{-2}$$

also $H_k(z) = \dfrac{Y_k(z)}{X_k(z)} \Rightarrow Y_k(z) = b_{k0} X_k(z) + b_{k1} z^{-1} X_k(z) + b_{k2} z^{-2} X_k(z).$

$$\Rightarrow y_k(n) = b_{k0} x_k(n) + b_{k1} x_k(n-1) + b_{k2} x_k(n-2)$$

Let $H(z) = 1 + \frac{6}{5} z^{-1} + \frac{7}{5} z^{-2} + \frac{26}{25} z^{-3} + \frac{1}{5} z^{-4}$

M=5

factorizing $\Rightarrow H(z) = \left[1 + \frac{1}{5} z^{-1} + z^{-2}\right]\left[1 + z^{-1} + \frac{1}{5} z^{-2}\right]$

$$= H_1(z) \cdot H_2(z).$$

Cascade Realizatⁿ: