Module 4

Structures for Realization of Discrete time systems: Realization of FIR and IIR filters using direct form structures and cascade form structures, Lattice structure for FIR Filters.

Introduction to Digital Signal (DS) Processors:

Introduction, Digital Signal Processor Architecture- Von Neumann architecture and Harvard architecture, Fixed- and Floating-Point Format for DS processors.

Text Books

Proakis&Manolakis, "Digital signal processing – Principles Algorithms & Applications", *Pearson education*, 4th Edition, New Delhi, 2007.

Li Tan, "Digital Signal Processing", Academic Press, *Elsevier*, 2007.

Basic IIR Filter Structures

The causal IIR digital filters we are concerned with in this course are characterized by a real rational transfer function of z^{-1} or, equivalently by a constant coefficient difference equation

From the difference equation representation, it can be seen that the realization of the causal IIR digital filters requires some form of feedback

An N-th order IIR digital transfer function is characterized by $2N+1$ unique coefficients, and in general, requires $2N+1$ multipliers and $2N$ two-input adders for implementation

Direct form IIR filters: Filter structures in which the multiplier coefficients are precisely the coefficients of the transfer function

Contd...

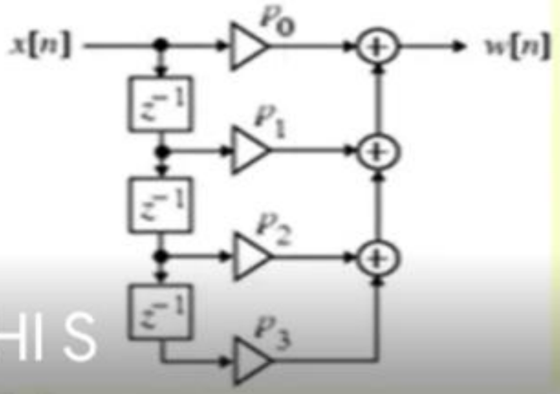
$$H(z) = \frac{P(z)}{D(z)} = \frac{p_0 + p_1 z^{-1} + p_2 z^{-2} + p_3 z^{-3}}{1 + d_1 z^{-1} + d_2 z^{-2} + d_3 z^{-3}}$$

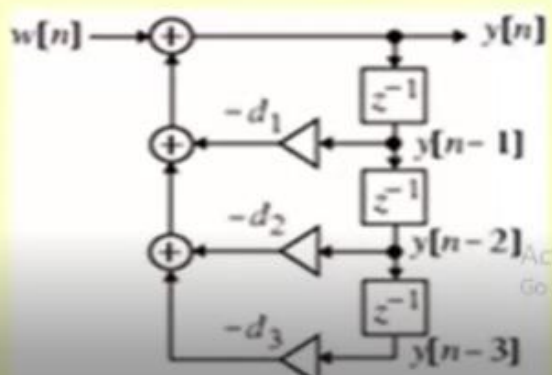
$$H_1(z) = \frac{W(z)}{X(z)} = P(z) = p_0 + p_1 z^{-1} + p_2 z^{-2} + p_3 z^{-3}$$

$$H_2(z) = \frac{Y(z)}{W(z)} = \frac{1}{D(z)} = \frac{1}{1 + d_1 z^{-1} + d_2 z^{-2} + d_3 z^{-3}}$$

$$w[n] = p_0 x[n] + p_1 x[n-1] + p_2 x[n-2] + p_3 x[n-3]$$

$$y[n] = w[n] - d_1 y[n-1] - d_2 y[n-2] - d_3 y[n-3]$$





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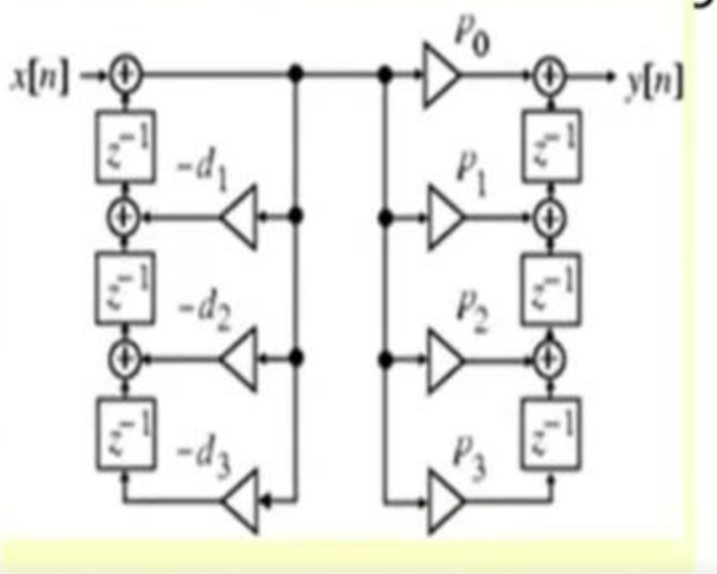
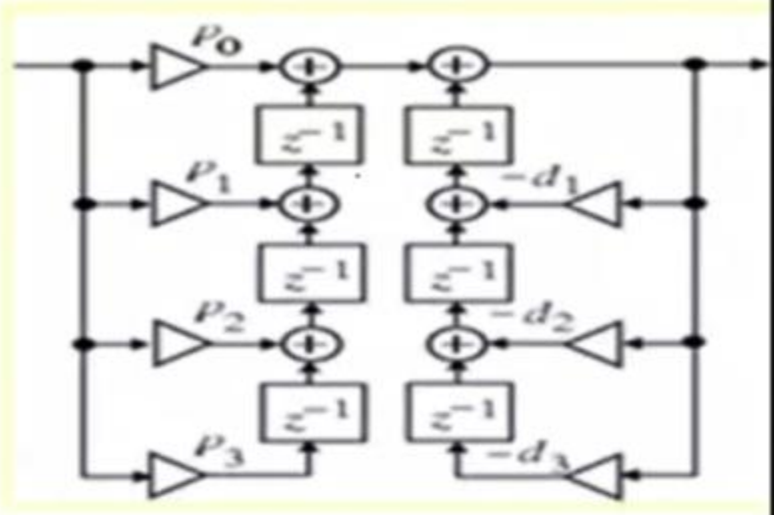
Contd...

- The direct form-I structure is non canonical as it requires 6 delay elements to realize a 3rd order transfer function





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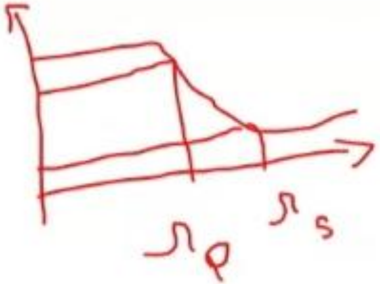
$A_p = 20\log(0.6) = -4.4\,dB$

$A_s = 20\log(0.1) = -20\,dB$

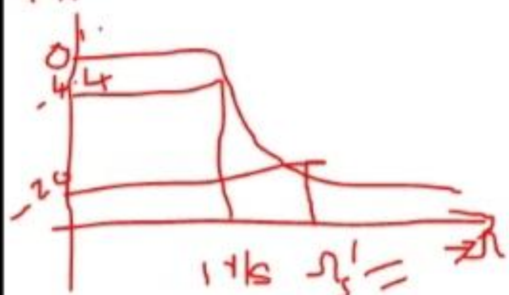
$\omega_p = 0.35\pi$

$\omega_s = 0.75\pi$



IIV

$\Omega_p = \frac{\omega_p}{T}$



BLT

$\Omega_p = \frac{2}{T}\tan^{-1}\left(\frac{\omega_p}{2}\right)$

$\Omega_s = \frac{2}{T}\tan^{-1}\left(\frac{\omega_s}{2}\right)$

$S \rightarrow \frac{2}{T}\left(\frac{1 - z^{-1}}{1 + z^{-1}}\right)$

(5) $H_n(S) = \dfrac{1}{S_n^2 + 1.414 S_n + 1}$

(6) $H_a(S) = H_n(S)\Big| =$

$S_n \rightarrow \dfrac{S}{\Omega_c'}$ if Ω_c is calculated for $\dfrac{1-\nu/c}{(\quad)}$

$\Omega_c' = \Omega_p \Omega_c$

$= 0.613(0.87)$

$S_n \rightarrow \dfrac{S}{\Omega_c}$ if Ω_c is calcu $\dfrac{\Omega_p \text{ given}}{(\quad)}$

$\Omega_c' = 0.53$