$$\frac{d_2^* + d_1^* z^{-1} + z^{-2}}{1 + d_1 z^{-1} + d_2 z^{-2}}$$

$$\frac{d_1^* + z^{-1}}{1 + d_1 z^{-1}}$$

$$\frac{d_1^* + e^{-j\omega}}{1 + d_1 e^{-j\omega}} = \frac{e^{-j\omega}(d_1^* e^{j\omega} + 1)}{1 + d_1 e^{-j\omega}}$$

$$= D^*\left(\frac{1}{z^*}\right) \qquad D\left(\frac{1}{z^*}\right) = 1 + d_1\left(\frac{1}{z^*}\right)^{-1} = 1 + d_1 z^*$$

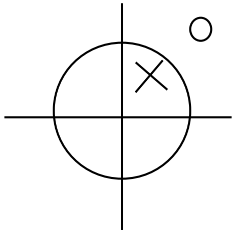
$$\frac{d_1^* + z^{-1}}{1 + d_1 z^{-1}} = \frac{z^{-1}(d_1^* z + 1)}{D(z)}$$

$D(\lambda) = 0$ be the pole

$$\lambda = re^{j\theta} \qquad \frac{1 - \frac{1}{d_1^*} z^{-1}}{1 - d_1 z^{-1}} = \frac{\frac{1}{d_1^*}(d_1^* - z^{-1})}{1 - d_1 z^{-1}}$$

$$\frac{1}{re^{-j\theta}} = \frac{1}{r} e^{j\theta}$$

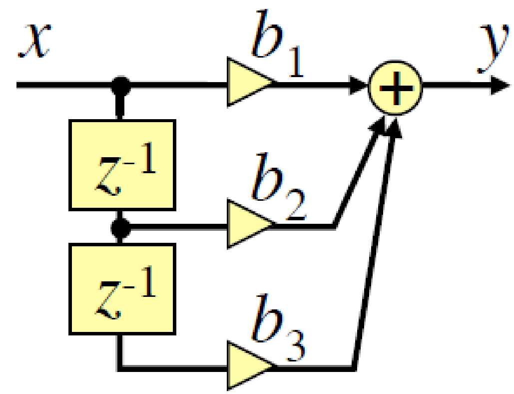
$\frac{1}{\lambda^*}$ be the zero



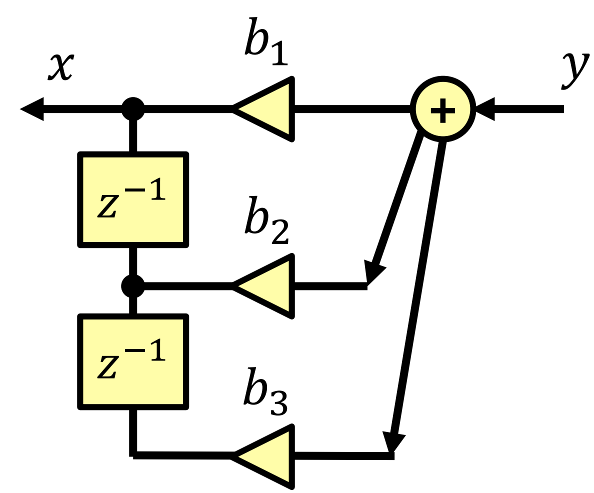
$$\frac{-d_1^* + z^{-1}}{1 - d_1 z^{-1}}$$

$$\because \quad \frac{1}{z^*} = \frac{1}{(1/\lambda^*)^*} = \lambda$$

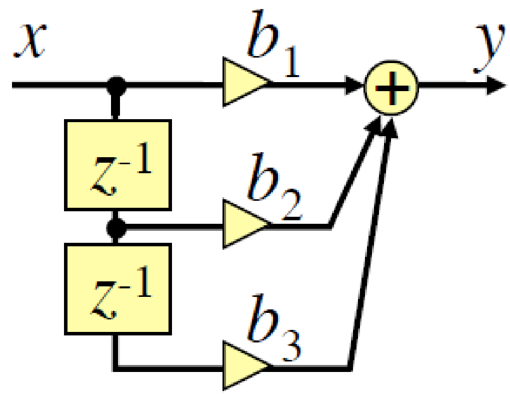
- Transposе
  - reverse paths



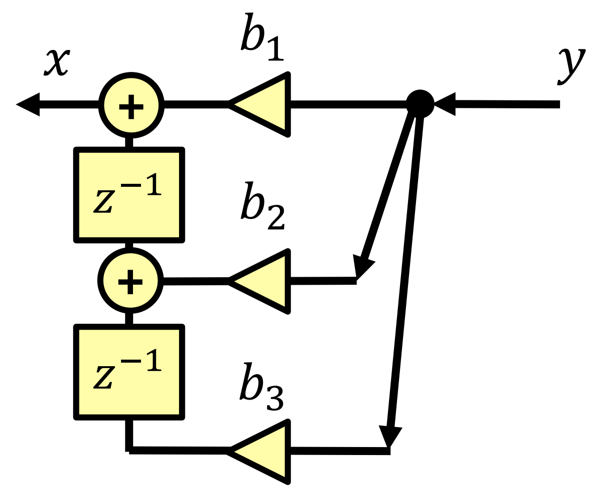
≡



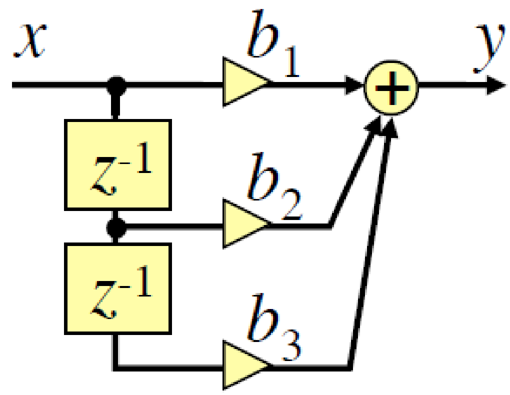
- Transpose
  - reverse paths
  - adders↔nodes



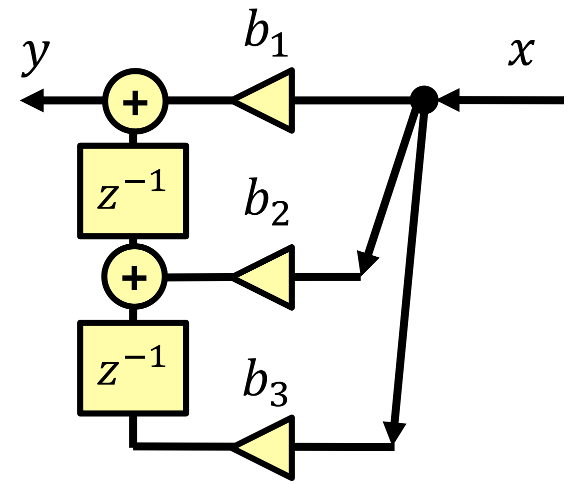
≡



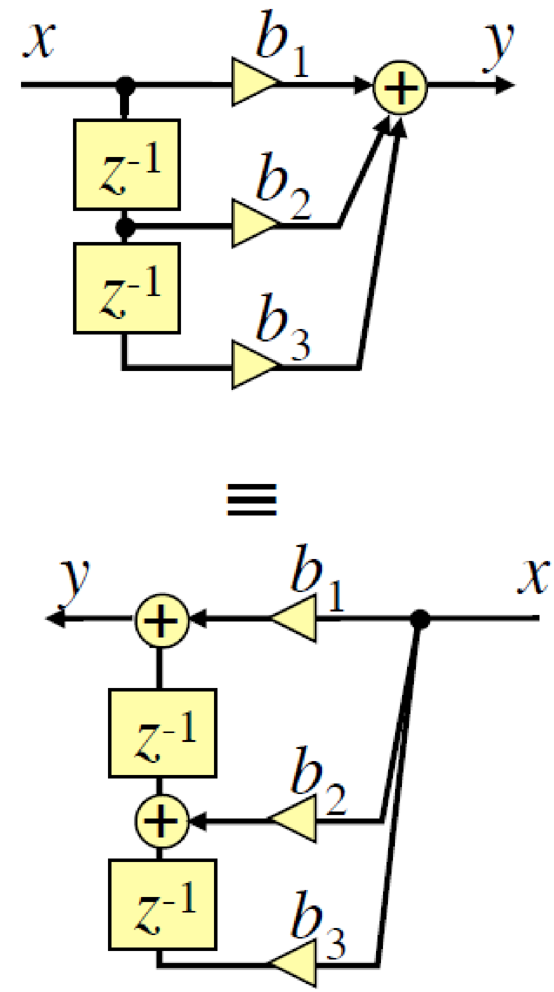
- Transpose
  - reverse paths
  - adders↔nodes
  - input↔output



≡

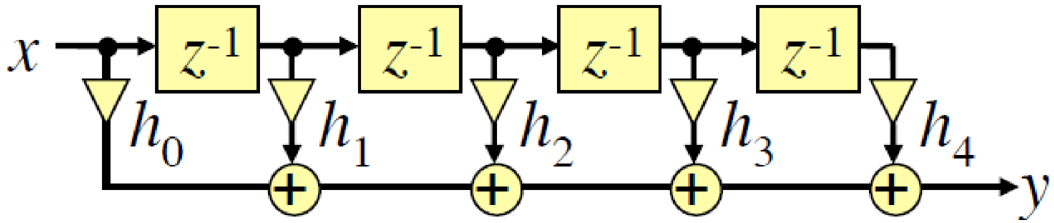


- Transpose
  - reverse paths
  - adders↔nodes
  - input↔output



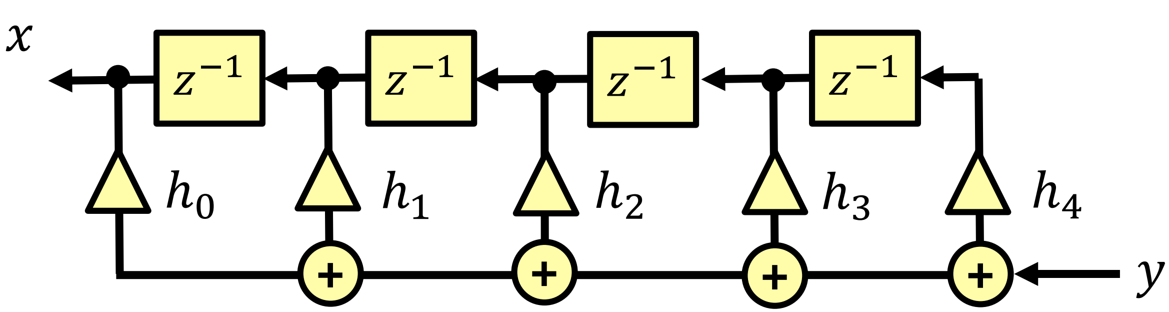
$$
\begin{aligned}
Y &= b_1 X + b_2 z^{-1} X + b_3 z^{-2} X \\
&= b_1 X + z^{-1}\left(b_2 X + z^{-1} b_3 X\right)
\end{aligned}
$$

- Direct form "Tapped Delay Line"

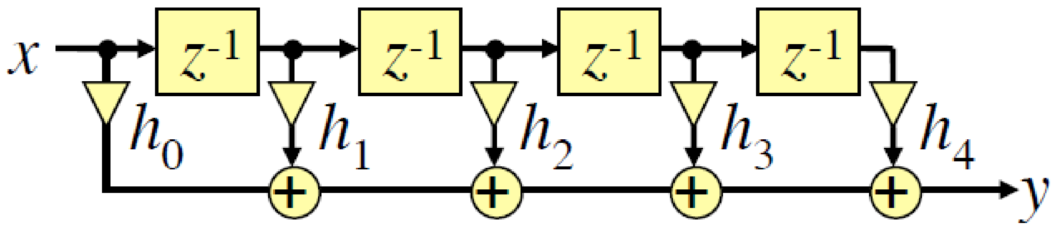


$$y[n] = h_0 x[n] + h_1 x[n-1] + \ldots$$
$$= \sum_{k=0}^{4} h_k x[n-k]$$

- Transpose
  - reverse paths

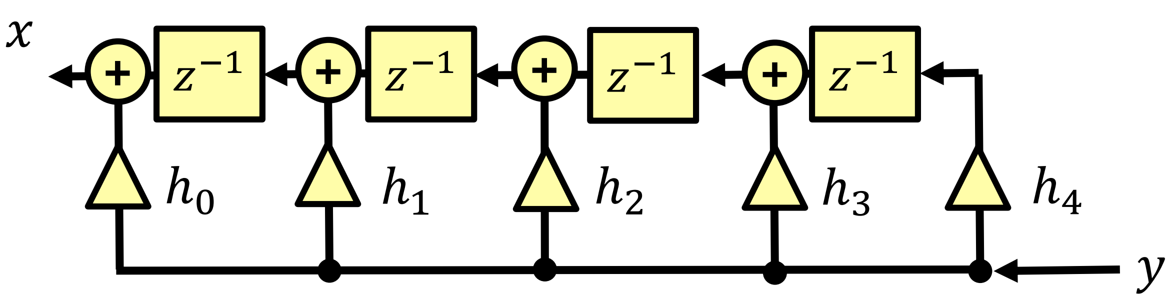


- Direct form "Tapped Delay Line"

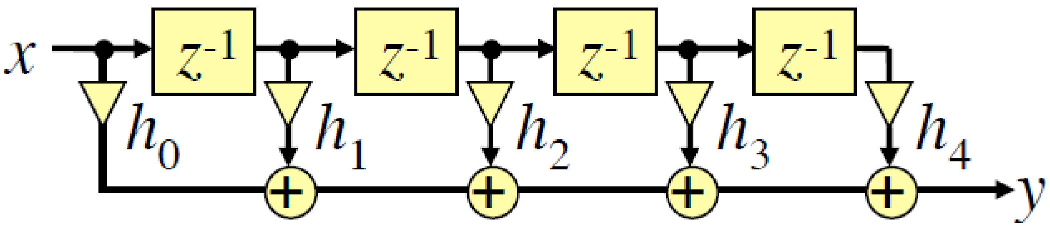


$$y[n] = h_0 x[n] + h_1 x[n-1] + \ldots$$
$$= \sum_{k=0}^{4} h_k x[n-k]$$

- Transpose
  - reverse paths
  - adders↔nodes

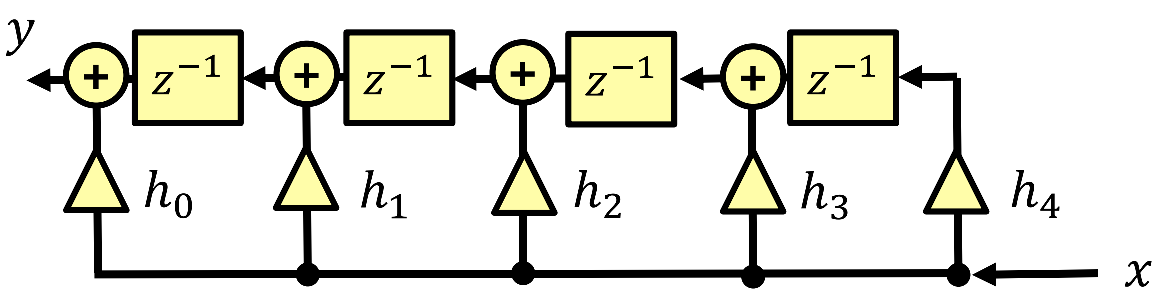


- Direct form “Tapped Delay Line”

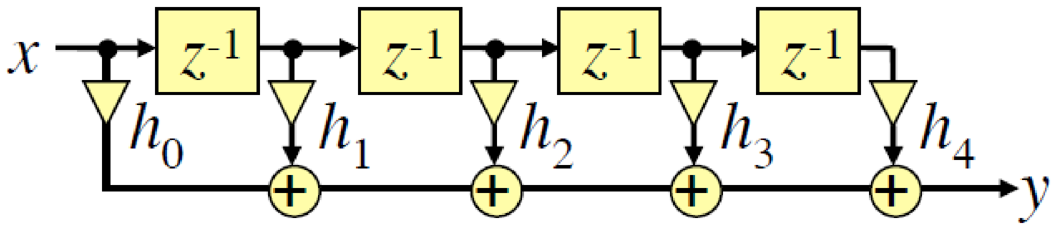


$$y[n] = h_0 x[n] + h_1 x[n-1] + \ldots$$
$$= \sum_{k=0}^{4} h_k x[n-k]$$

- Transpose
  - reverse paths
  - adders↔nodes
  - input↔output

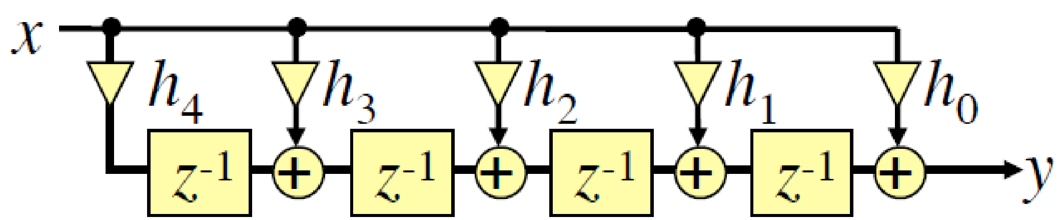


- Direct form "Tapped Delay Line"

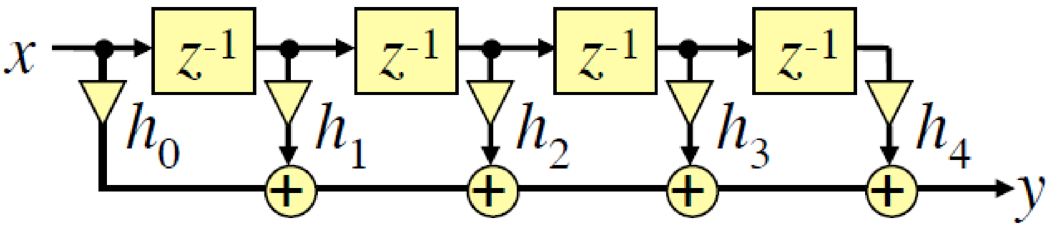


$$y[n] = h_0 x[n] + h_1 x[n-1] + \ldots$$
$$= \sum_{k=0}^{4} h_k x[n-k]$$

- Transpose

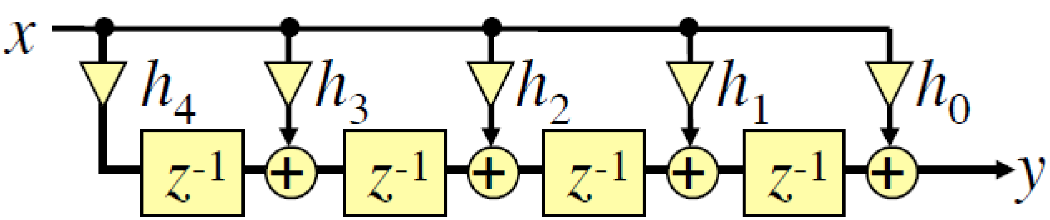


Direct form "Tapped Delay Line"



$$y[n] = h_0 x[n] + h_1 x[n-1] + \dots$$
$$= \sum_{k=0}^{4} h_k x[n-k]$$

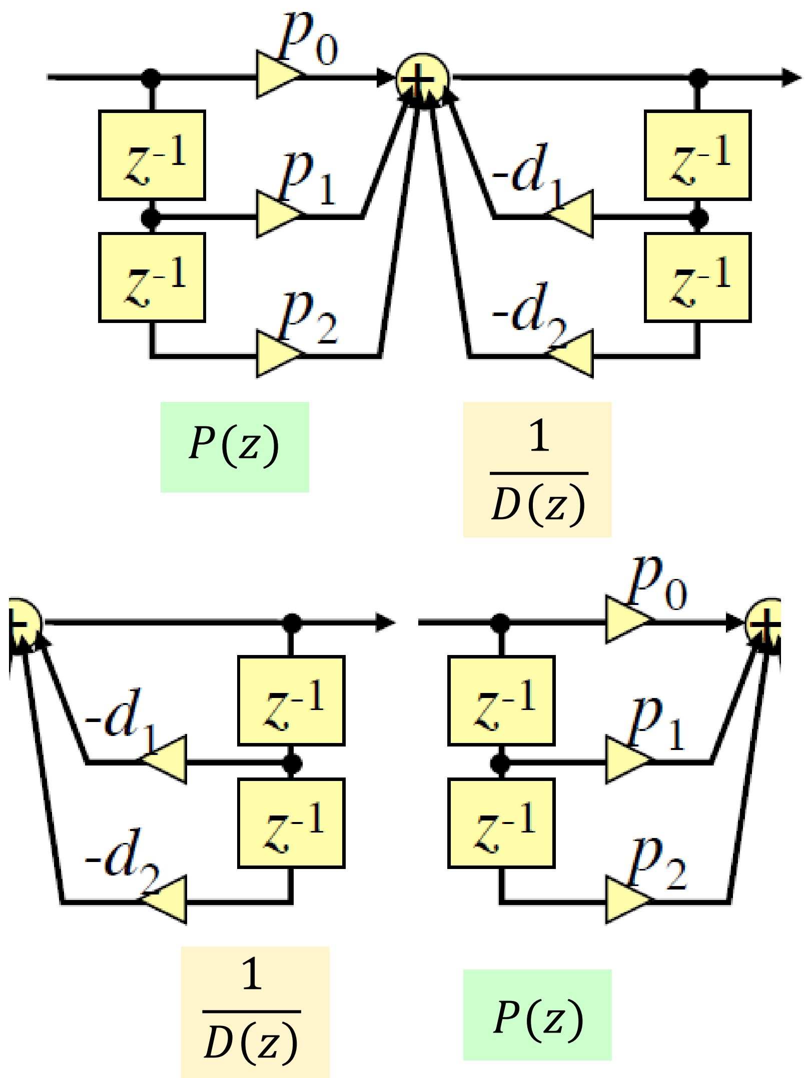
Transpose



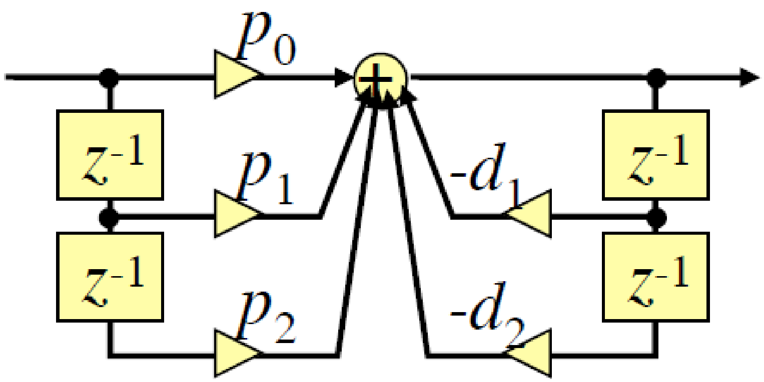
$$y[5] = h_0 x[5] + h_1 x[4] + h_2 x[3] + h_3 x[2] + h_4 x[1]$$

$h_4 x[1]$	$h_3 x[1]$	$h_2 x[1]$	$h_1 x[1]$	$h_0 x[1]$
$h_4 x[2]$	$h_3 x[2]$	$h_2 x[2]$	$h_1 x[2]$	$h_0 x[2]$
$h_4 x[3]$	$h_3 x[3]$	$h_2 x[3]$	$h_1 x[3]$	$h_0 x[3]$
$h_4 x[4]$	$h_3 x[4]$	$h_2 x[4]$	$h_1 x[4]$	$h_0 x[4]$
$h_4 x[5]$	$h_3 x[5]$	$h_2 x[5]$	$h_1 x[5]$	$h_0 x[5]$
$h_4 x[6]$	$h_3 x[6]$	$h_2 x[6]$	$h_1 x[6]$	$h_0 x[6]$

- Hence, Direct form I

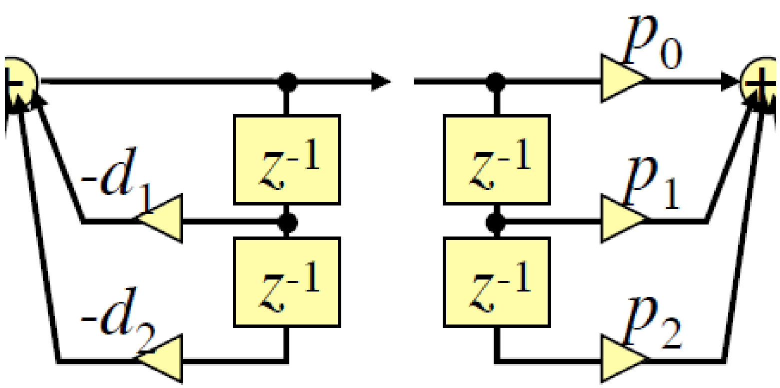


- Hence, Direct form I



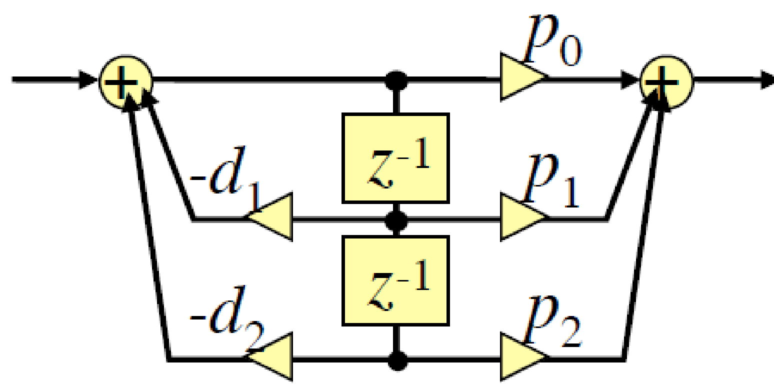
$P(z)$

$\frac{1}{D(z)}$



$\frac{1}{D(z)}$

$P(z)$



01.1

$$0 \cdot 2^1 + 1 \cdot 2^0 + 1 \cdot 2^{-1} = 1.5$$

01.1

$$0 \cdot 2^1 + 1 \cdot 2^0 + 1 \cdot 2^{-1} = 1.5$$

0.11

$$0 \cdot 2^0 + 1 \cdot 2^{-1} + 1 \cdot 2^{-2} = 0.75$$

01.1

$$0 \cdot 2^1 + 1 \cdot 2^0 + 1 \cdot 2^{-1} = 1.5$$

0.11

$$0 \cdot 2^0 + 1 \cdot 2^{-1} + 1 \cdot 2^{-2} = 0.75$$

011.

$$0 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0 += 3$$