# UNIT-1
# (Lecture-5)

## Realization of Digital Systems:
## Parallel Form Realization of an IIR Systems



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# Parallel Form IIR Digital Filter Structures

- A partial-fraction expansion of the transfer function in $z^{-1}$ leads to the **parallel form I** structure
- Thus, assuming simple poles, the transfer function $H(z)$ can be expressed in the form

$$H(z) = \gamma_0 + \sum_k \left( \frac{\gamma_{0k} + \gamma_{1k} z^{-1}}{1 + \alpha_{1k} z^{-1} + \alpha_{2k} z^{-2}} \right)$$

- In the above, for a real pole $\alpha_{2k} = \gamma_{1k} = 0$

# Parallel Form IIR Digital Filter Structures

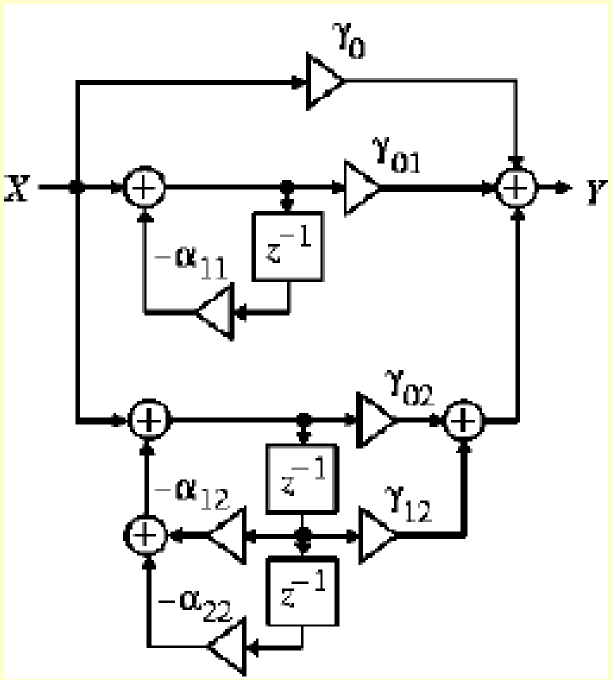
- A direct partial-fraction expansion of the transfer function in $z$ leads to the **parallel form II** structure
- Assuming simple poles, in this case we arrive at

$$H(z) = \delta_0 + \sum_k \left( \frac{\delta_{0k} z^{-1} + \delta_{2k} z^{-2}}{1 + \alpha_{1k} z^{-1} + \alpha_{2k} z^{-2}} \right)$$

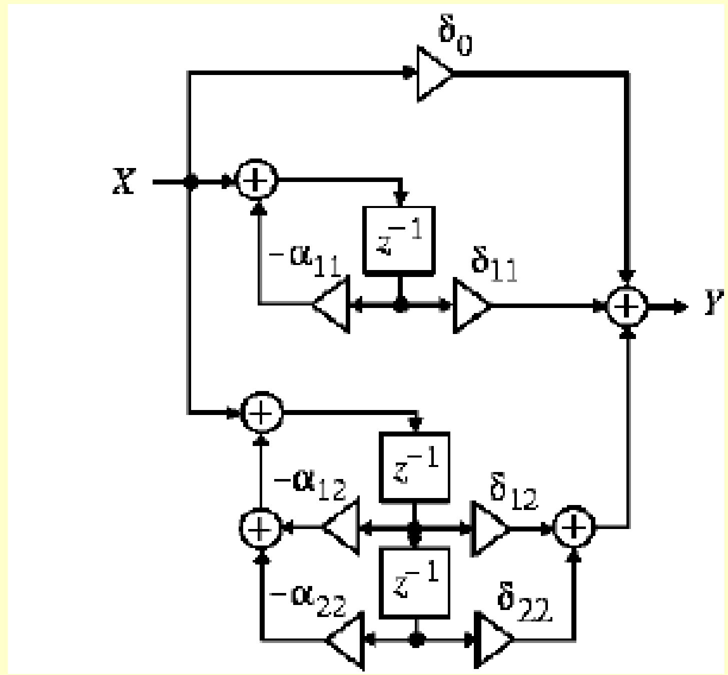
- Here, for a real pole $\alpha_{2k} = \delta_{2k} = 0$

# Parallel Form IIR Digital Filter Structures

- The two basic parallel realizations of a 3rd-order IIR transfer function are shown below




Parallel form I




Parallel form II



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# Parallel Form IIR Digital Filter Structures

- Example: A partial-fraction expansion of

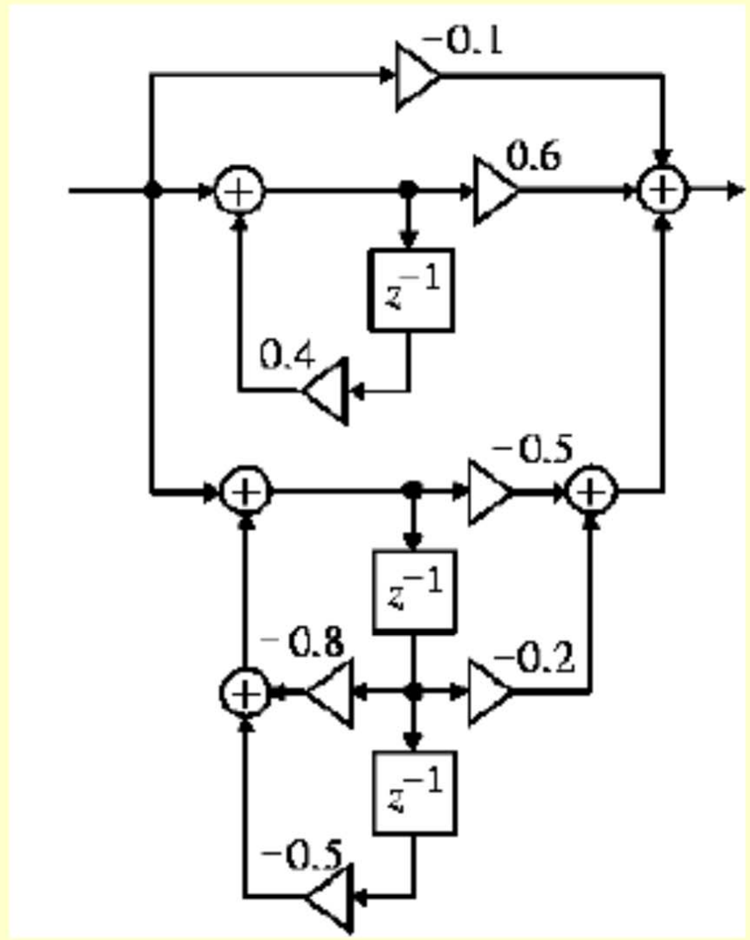
$$H(z) = \frac{0.44z^{-1} + 0.362z^{-2} + 0.02z^{-3}}{1 + 0.4z^{-1} + 0.18z^{-2} - 0.2z^{-3}}$$

in $z^{-1}$ yields

$$H(z) = -0.1 + \frac{0.6}{1 - 0.4z^{-1}} + \frac{-0.5 - 0.2z^{-1}}{1 + 0.8z^{-1} + 0.5z^{-2}}$$

# Parallel Form IIR Digital Filter Structures

- The corresponding parallel form I realization is shown in the figure



# Parallel Form IIR Digital Filter Structures

- Likewise, a partial-fraction expansion of $H(z)$ in $z$ yields

$$H(z) = \frac{0.24}{z-0.4} + \frac{0.2z+0.25}{z^2+0.8z+0.5}$$

$$= \frac{0.24z^{-1}}{1-0.4z^{-1}} + \frac{0.2z^{-1}+0.25z^{-2}}{1+0.8z^{-1}+0.5z^{-2}}$$

- The corresponding parallel form II realization is shown in the figure