Outline

- IIR Sytems
  - Direct form I
  - Direct form II
  - Cascade form
  - Parallel form
- Signal Flow Diagrams
- Representation of numbers

IIR Implementations

- An IIR system is:

$$y[n] = \sum_{k=1}^{\infty} h[k]x[n-k]$$

or

$$\sum_{k=1}^{N} a_k y[n-k] = \sum_{k=1}^{M} b_k x[n-k]$$

- The system function has the general form:

$$H(z) = \frac{\sum_{k=0}^{M} b_k z^{-k}}{1 + \sum k = 1^N a_k z^{-k}}$$

IIR Implementations: Direct Form I

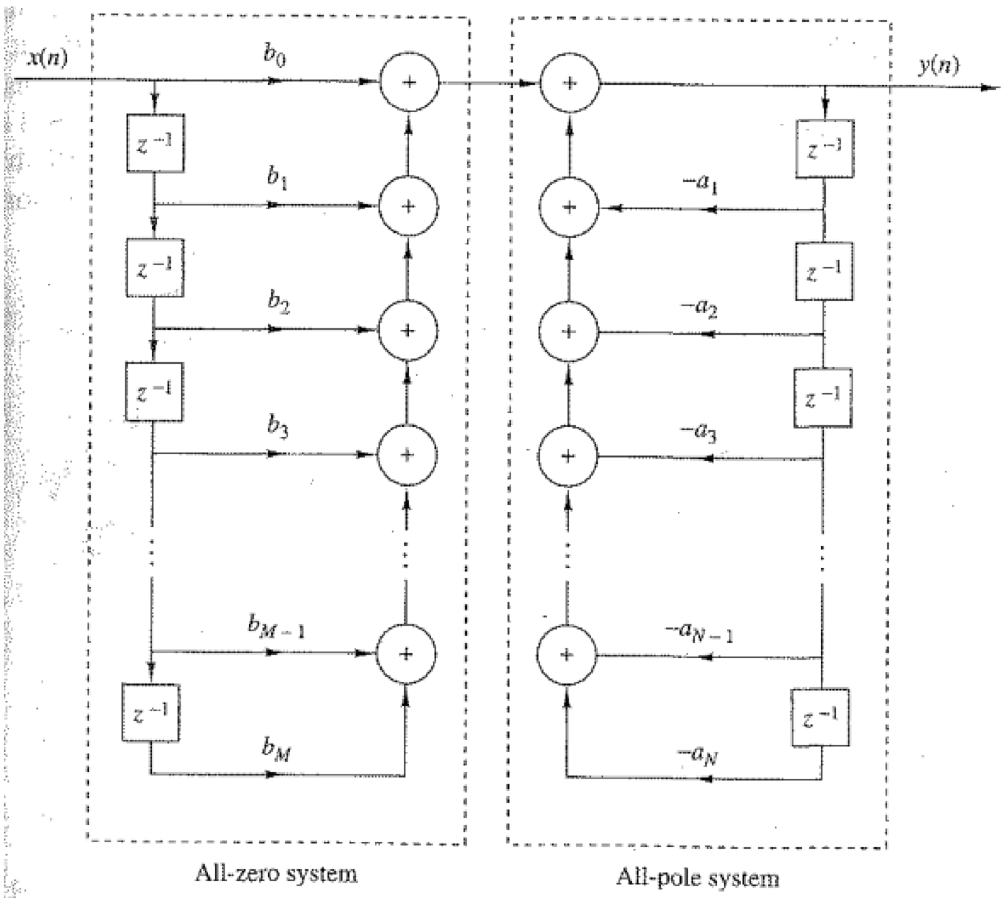


Figure 9.3.1 Direct form I realization.

IIR Implementations: Direct Form II

- Interchanging the order of summation and delays we obtain the direct form II

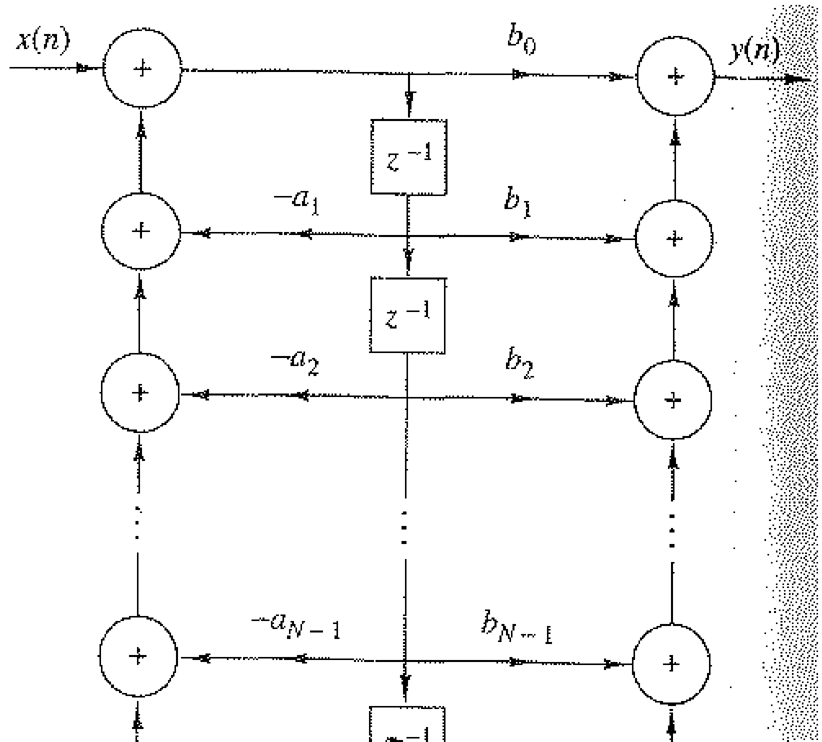


Figure 9.3.2. Direct form II

IIR Implementations: Cascade Form

- The system function can be decomposed into products of smaller system functions:

$$H(z) = \Pi_{k=1}^{N} H_k(z) = \Pi_{k=1}^{N} \frac{b_{k0} + b_{k1}z^{-1} + b_{k2}z^{-2}}{1 + a_{k1}z^{-1} + a_{k2}z^{-2}}$$

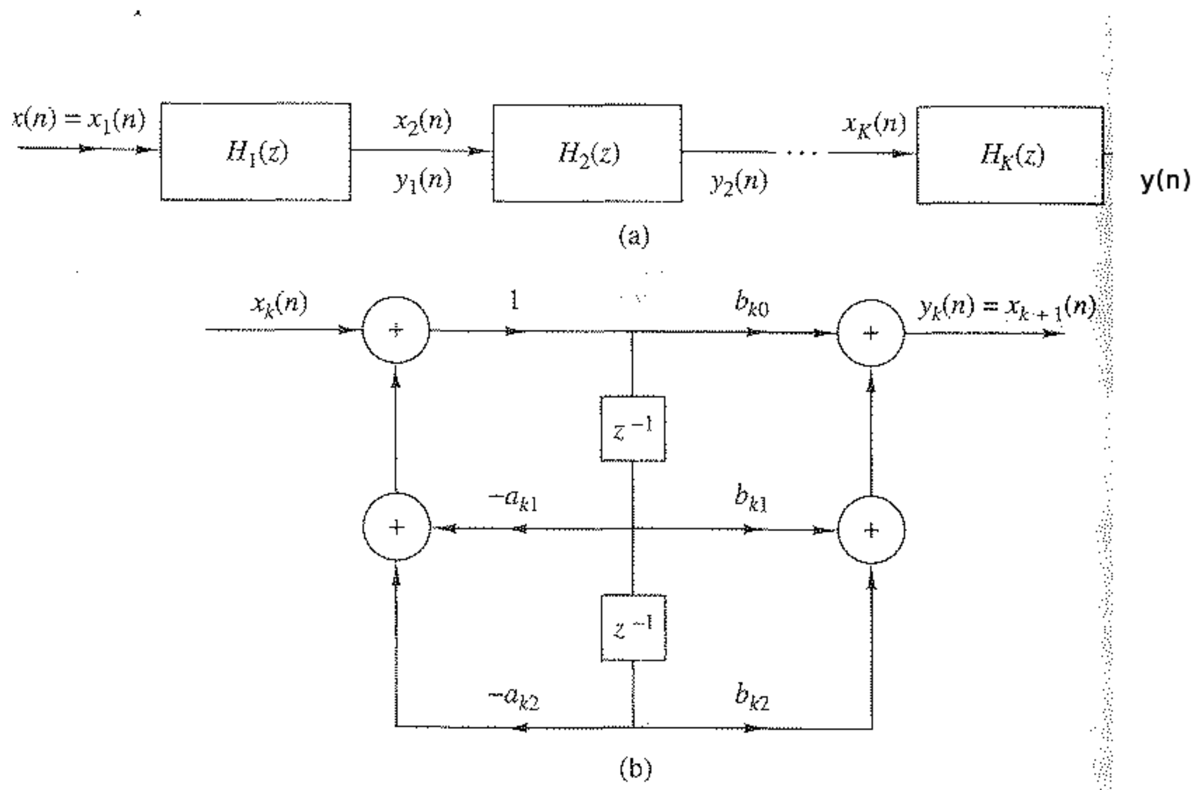


Figure 9.3.8. Cascade form

IIR Implementations: Parallel Form

- The system function can be decomposed into summations of smaller system functions:

$$H(z) = \sum_{k=1}^{M} H_k(z) = C + \sum_{k=1}^{M} \frac{b_{k0} + b_{k1}z^{-1}}{1 + a_{k1}z^{-1} + a_{k2}z^{-2}}$$

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

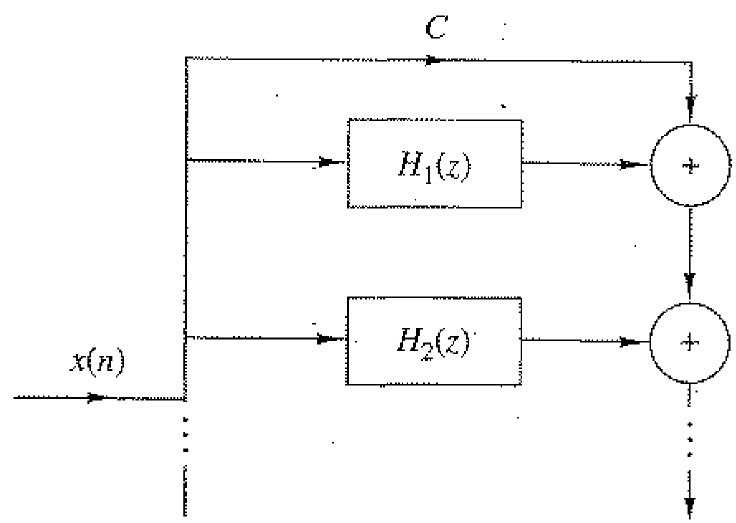
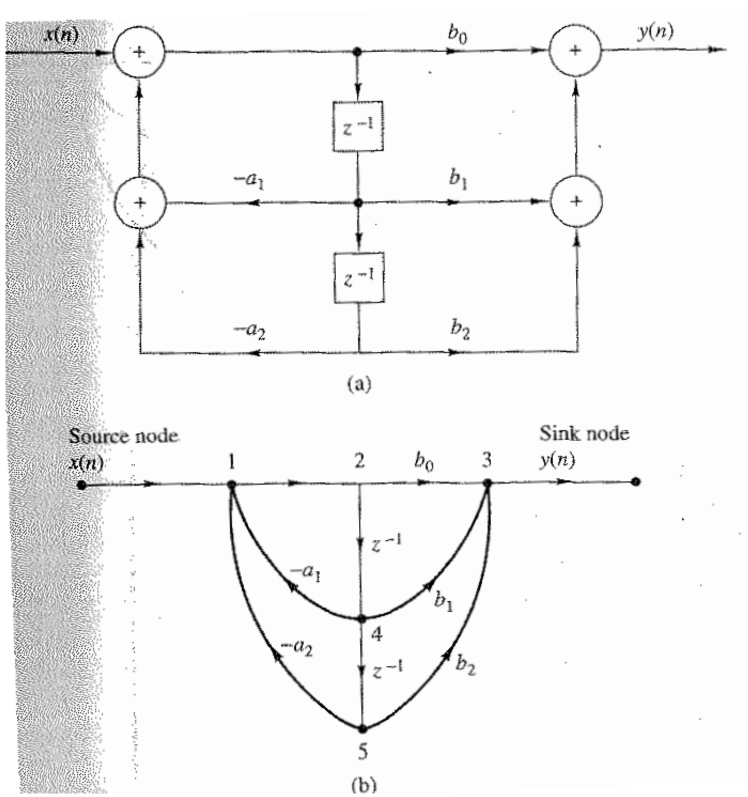


Figure 9.3.9. Parallel form

Signal Flow Diagrams

- Just another way to draw block diagrams for us
- In fact used in graph theory with a more complicated and extensive framework



Representation of Numbers

- Fixed point representations: each bit corresponds to a power of 2, and the negative numbers can be represented in one of three ways:
  - Sign magnitude format: the most significant bit is set to 1 for negative numbers
  - One's complement: the negative of a number is obtained by switching 1's and 0's
  - Two's complement: the negative number is 2.0 minus the positive number
- Floating point representations: provides larger dynamic range with non-uniform representation