5.14.3 *Signal flowgraph*

A signal flowgraph is a graphical representation of the relationship between the variables of a set of linear difference equations. The basic elements of a signal flowgraph are branches and nodes. The signal flow graph is basically a set of directed branches that connect at nodes. A node represents a system variable, which is equal to the sum of incoming signals from all branches connecting to the node. There are two types of nodes. Source nodes are nodes that have no entering branches. Sink nodes are nodes that have only entering branches. A signal travels along a branch from one node to another node. The signal out of a branch is equal to the branch gain times the signal into the branch. The arrow head shows the direction of the branch and the branch gain is indicated next to the arrow head. The delay is indicated by the branch transmittance z^{-1}. When the branch transmittance is unity, it is left unlabeled.

Let us consider a block diagram representation of a first order digital filter shown in Fig. 5.41a. The system block diagram can be converted to the signal flow graph shown in Fig. 5.41b. We find that the flow graph contain four nodes, out of which two nodes are summing nodes, while the other two nodes represent branching points. Branch transmittances are indicated next to the arrowhead and the delay is indicated by the branch transmittance z^{-1}.

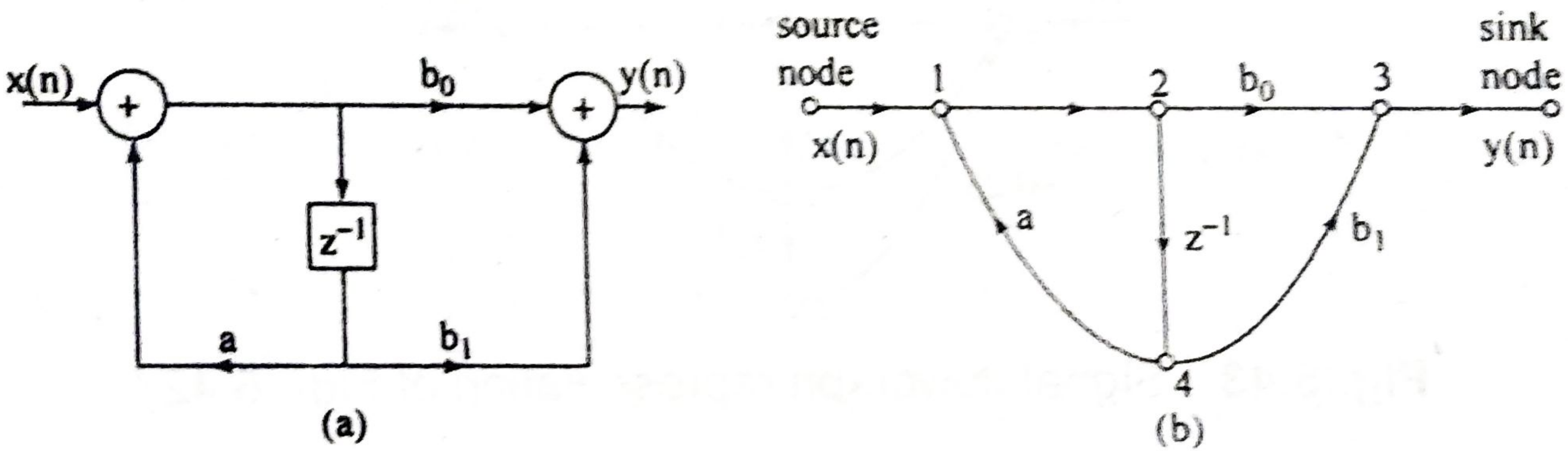


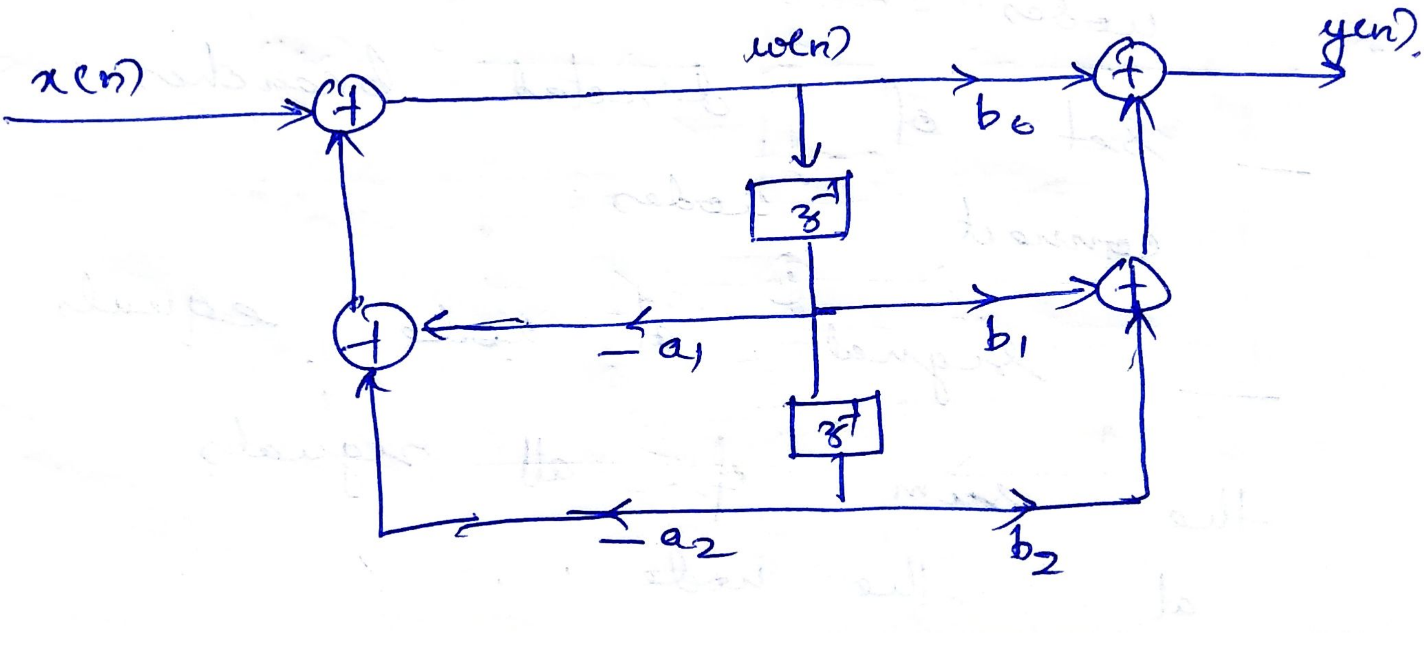
Fig. 5.41 (a) Block diagram representation of first-order digital filter (b) Signal flow graph representation of first-order digital filter

Transposed form (Transposed structure)

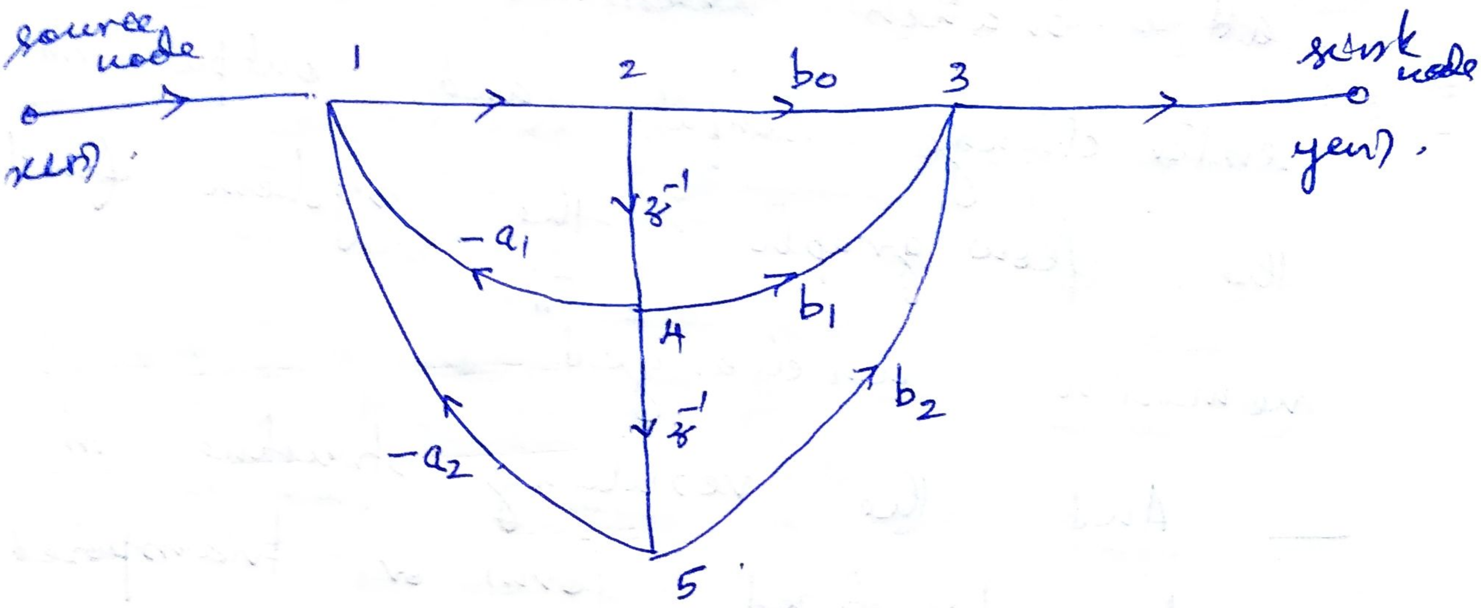
Consider the two pole two zero IIR s/m depicted in fig below.

$$H(z) = \frac{\sum_{k=0}^{2} b_k z^{-k}}{1 + \sum_{k=1}^{2} a_k z^{-k}}$$

$$= \frac{b_0 + b_1 z^{-1} + b_2 z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}}$$



corresponding signal flow graph.



node 1, 3 ⟶ summing node.
(ie they contain adders)

2, 4, 5 ⟶ branch points.

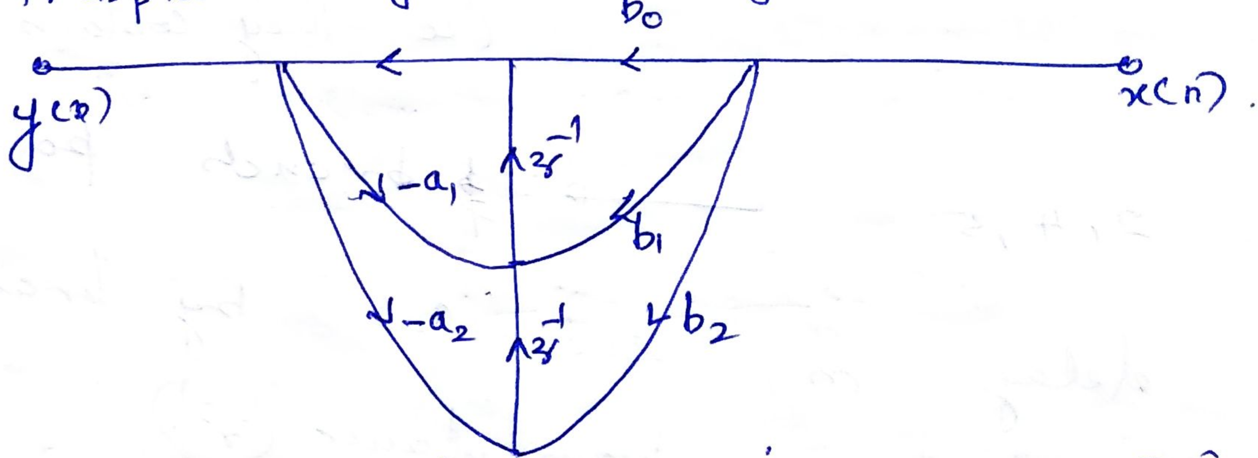
delay is indicated by branch transmittance (z^{-1})

— input to s/m originate at source node and o/p is taken from sink node.

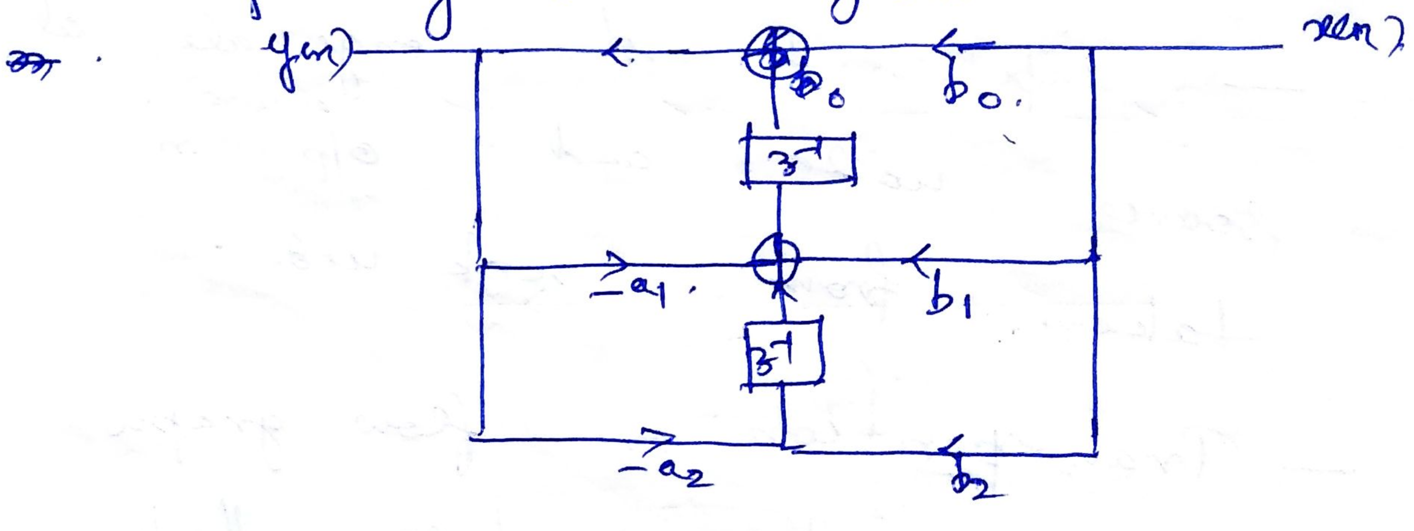
— Transposition or flow graph reversed theorm states that "if we reverse the direction of all branch transmittance and interchange input and output in the flow graph the system function remain unchanged"

— And the resulting structure is called transposed form or transposed structure.

— Transposed signal flow graph.

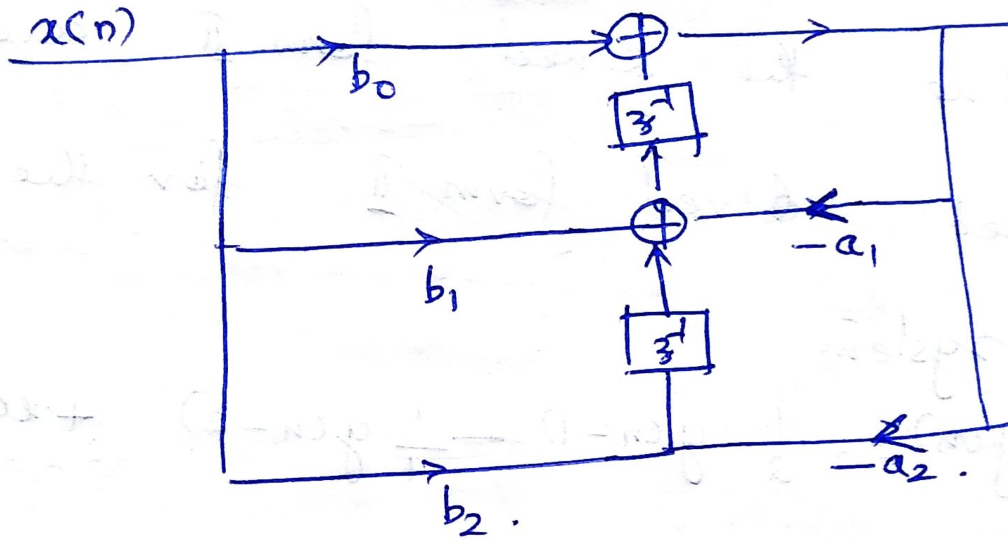


— corresponding block diagram realization



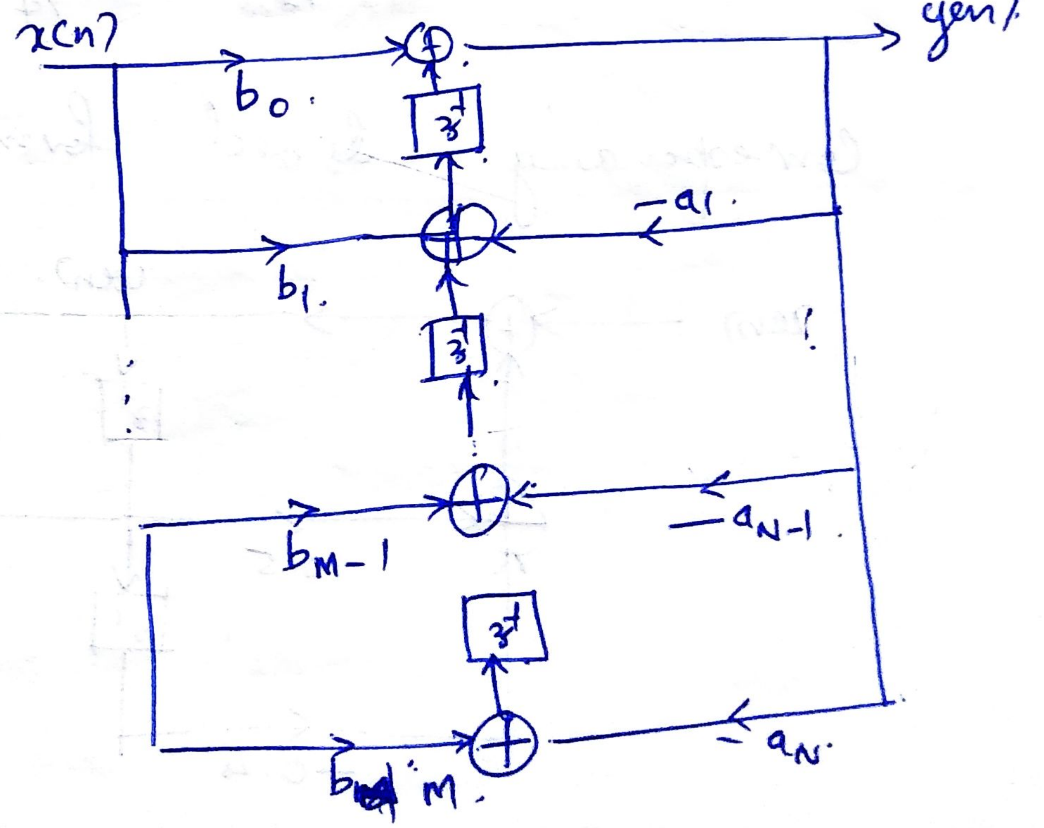
— Transposition resulted in branching nodes become adder nodes and vice versa.

— we can redraw the transposed form as



HW. Obtain the generalized transposed ~~form~~ direct form II structure for an IIR s/m.

Ans:



if M = N

— Transposed direct form II structure require same number of multiplier adder and memory locations as the original direct form II. structure.

Q) Determine the transposed direct form II for the given system.

$$y(n) = \frac{1}{2} y(n-1) - \frac{1}{4} y(n-2) + x(n) + x(n-1)$$

Ans:

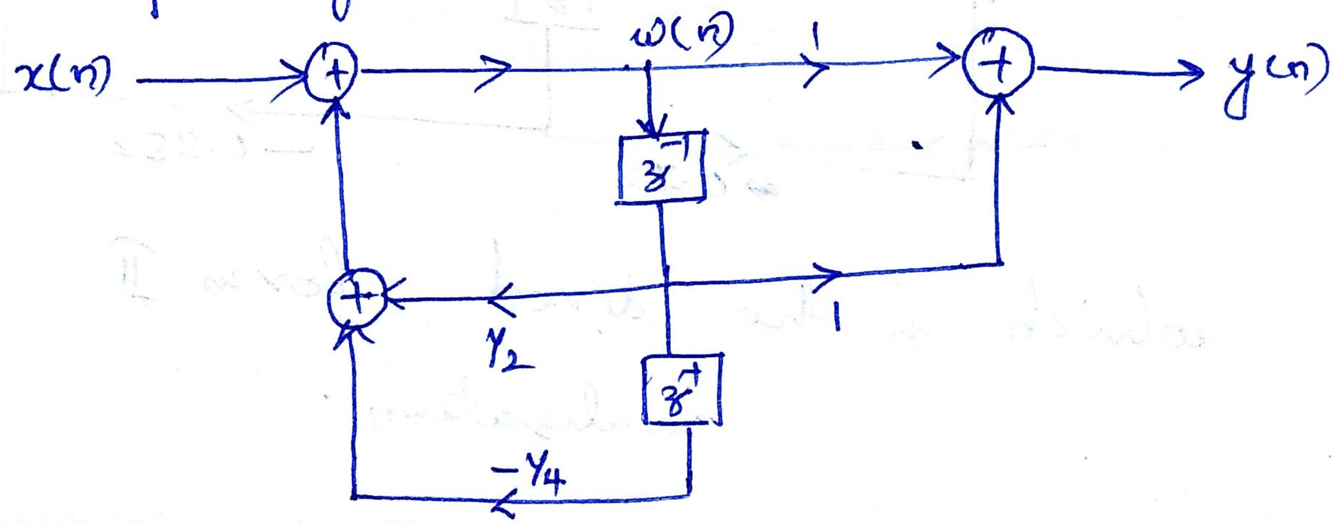
Taking z transform

$$Y(z) = \frac{1}{2} z^{-1} Y(z) - \frac{1}{4} z^{-2} Y(z) + X(z) + z^{-1} X(z)$$

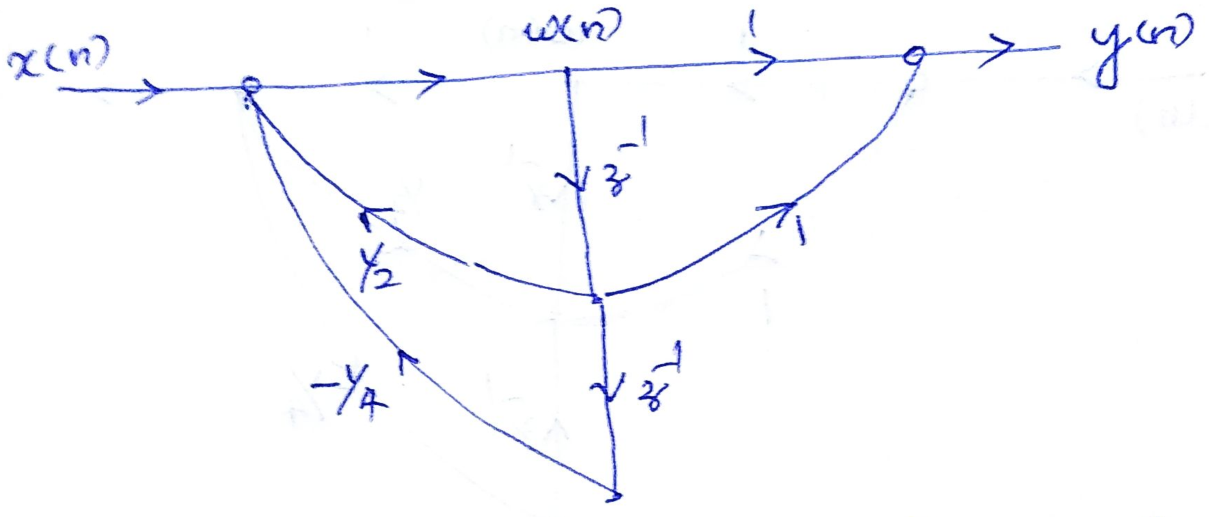
∴ The system function

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1 + z^{-1}}{1 - \frac{1}{2} z^{-1} + \frac{1}{4} z^{-2}}$$

Corresponding direct form II realization is



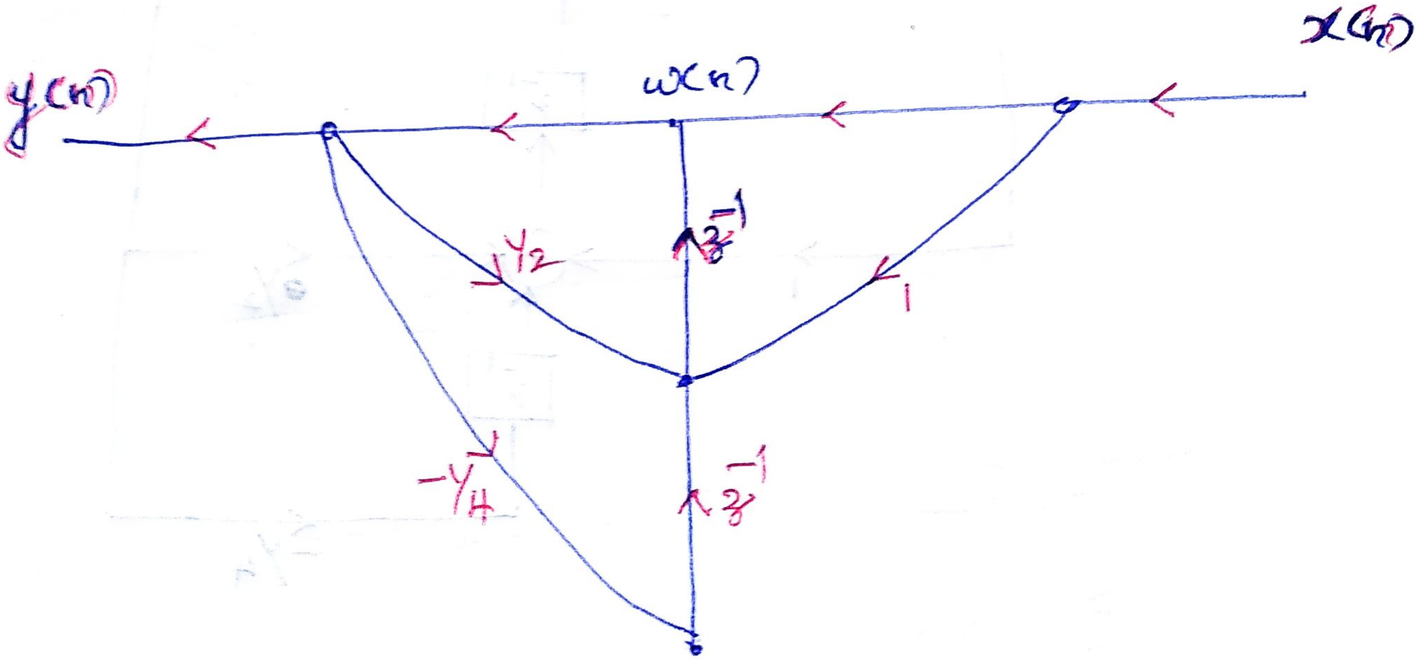
Corresponding signal flow graph.



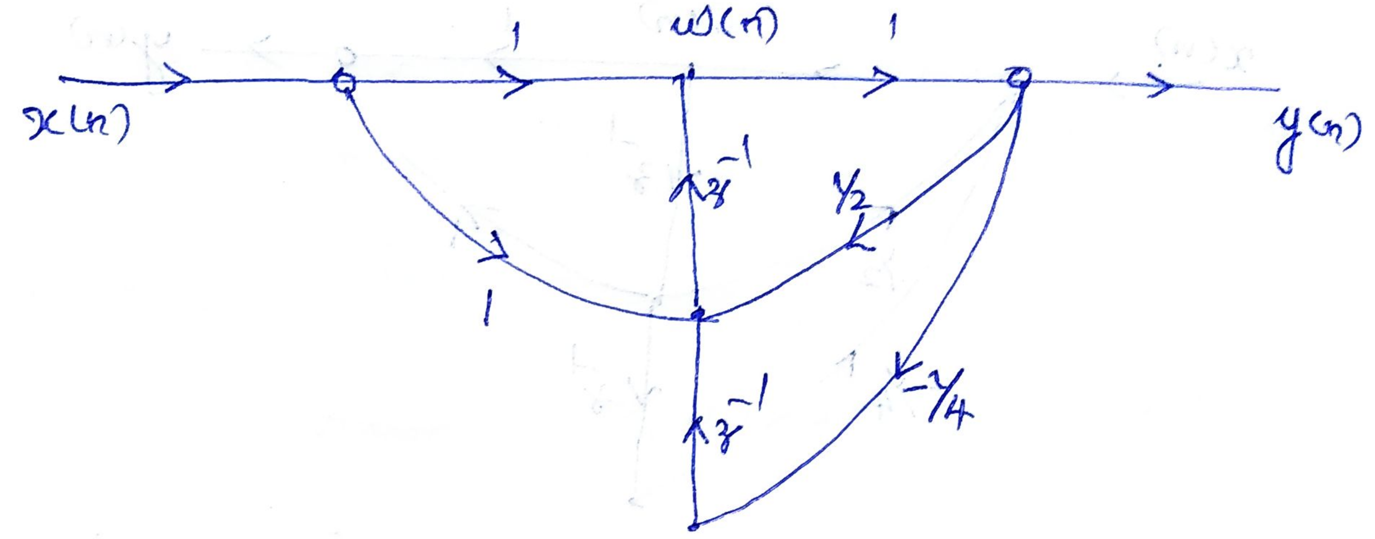
to get the transposed signal flow graph.

① inter change input and output

② reverse the direction of all branch transmittance.



This can be redrawn as:
(i/p on left side and output on right side)



Corresponding transposed direct form II structure is