Chapter 3- Exercise 7

Exercise 7. (a). The critical path of one multiply-add time can be achieved by using the transpose FIR filter structure as shown in Figure 3.7(a).

(b). The block filter with block size 3 can be described by

$$
\begin{aligned}
y(3k) &= ax(3k) + bx(3k-4) + cx(3k-6) \\
y(3k+1) &= ax(3k+1) + bx(3k-3) + cx(3k-5) \\
y(3k+2) &= ax(3k+2) + bx(3k-2) + cx(3k-4).
\end{aligned}
\tag{3.7}
$$

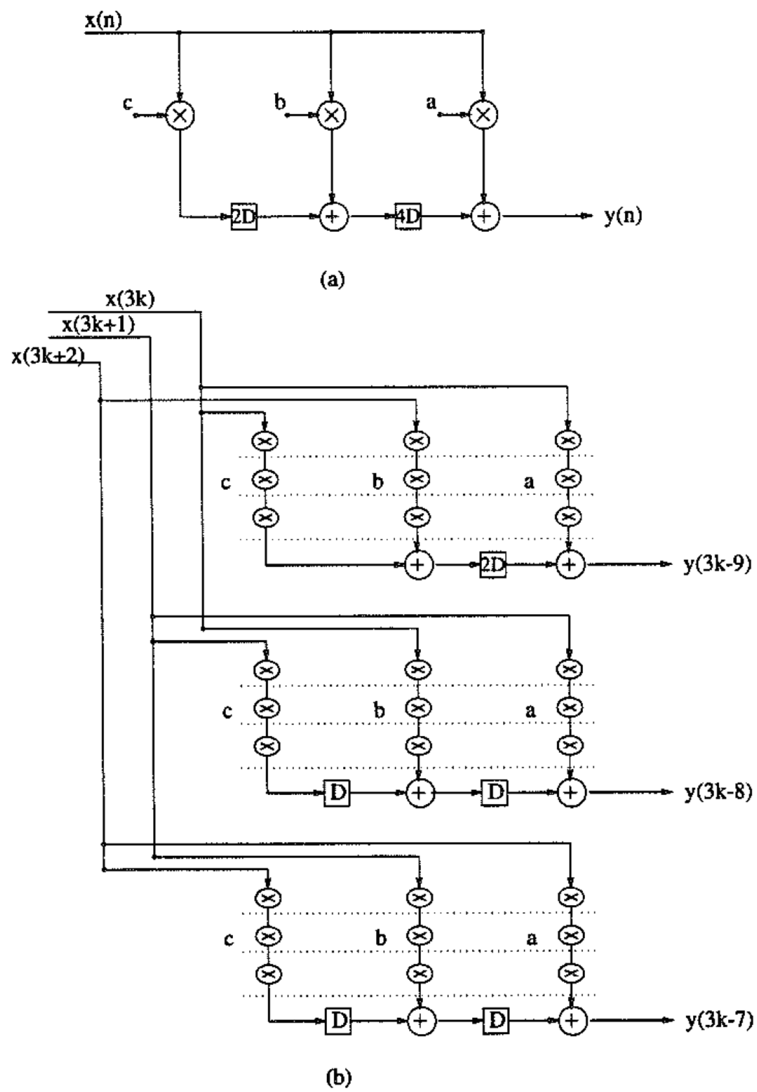


Fig. 3.7 (a):Transpose FIR filter for Exercise 7; (b):Pipelined Block Filter for Exercise 7

Chapter 4- Exercise 1

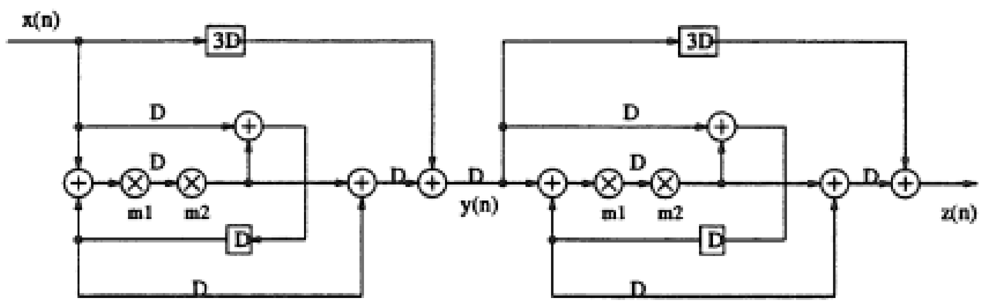
(a)

$$T_{I_bound} = \frac{T_m + 2T_a}{2} = 18ns \tag{4.1}$$

(b)

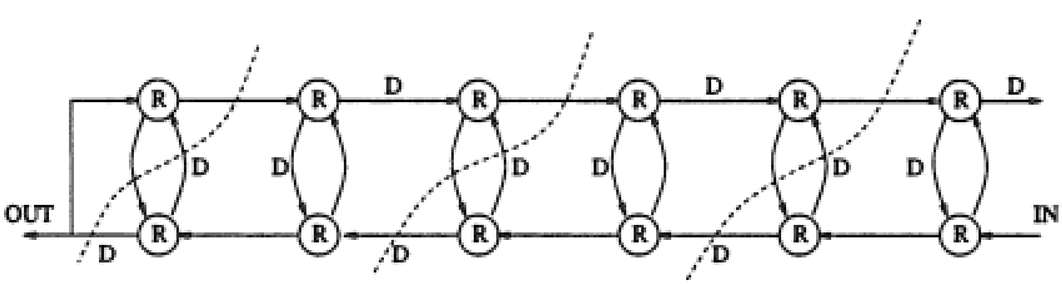
$$T_{critical} = 2(T_m + 3T_a) = 88ns \tag{4.2}$$

(c)



Chapter 4- Exercise 4

$$T_\infty = 2T \tag{4.5}$$
$$T_{critical} = 7T \tag{4.6}$$

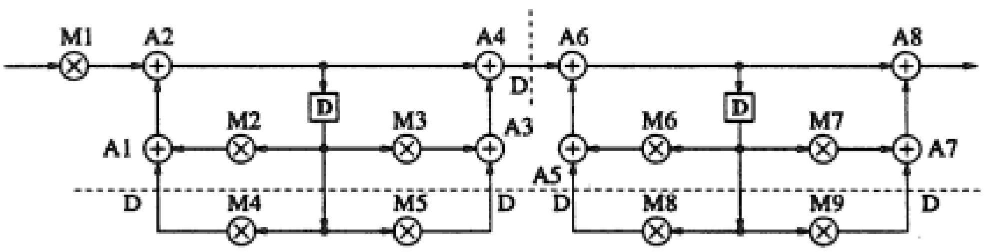


Chapter 4- Exercise 5

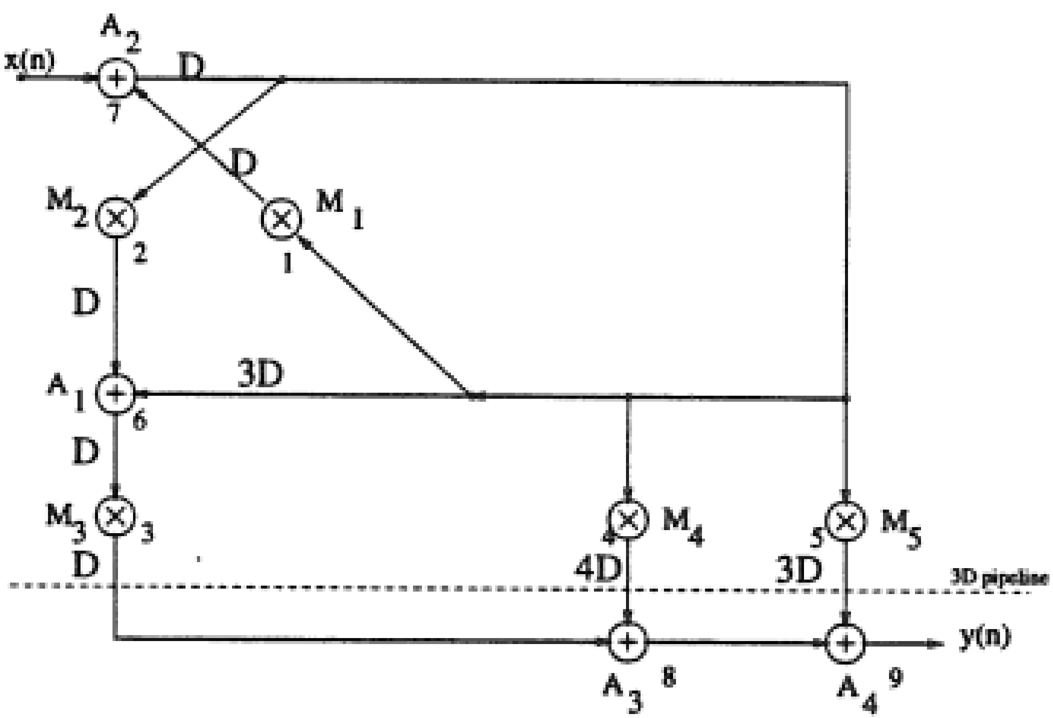
$$T_\infty = 4 \quad (4.7)$$

$$T_{critical} = 7 \quad (4.8)$$

(b)The minimum achievable clock period obtained with pipelining and retiming is the iteration bound of the DFG, which equals to 4u.t. in this problem.



Chapter 4- Exercise 10



Chapter 5- Exercise 1

(a). The 3-unfolded DFG is as shown in Figure 4.1.

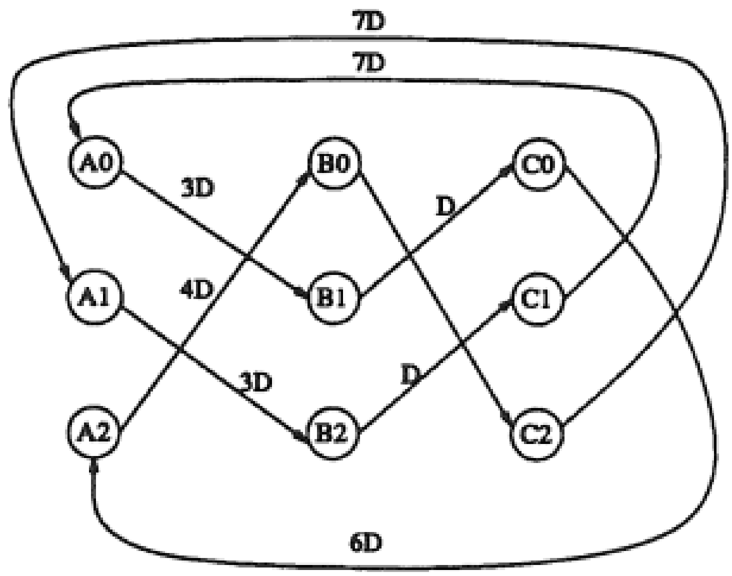
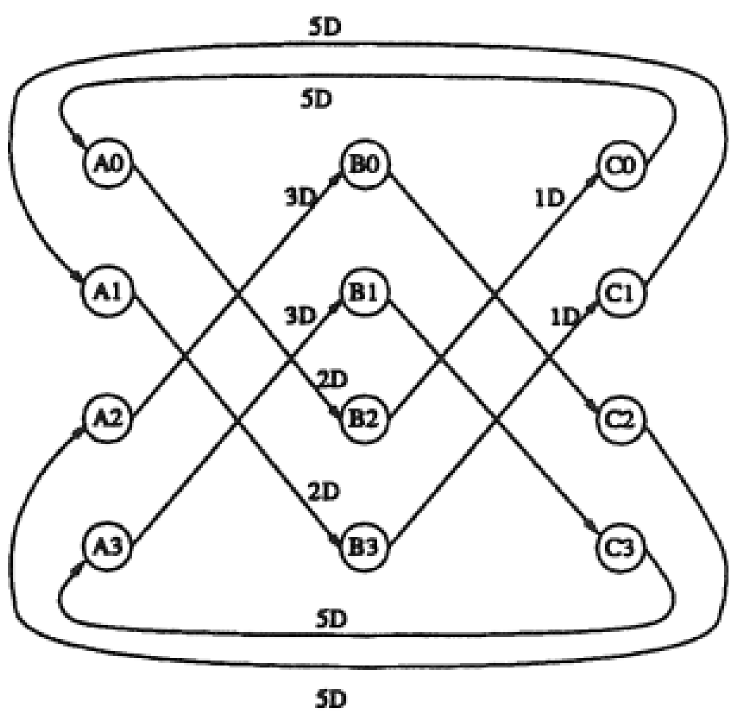


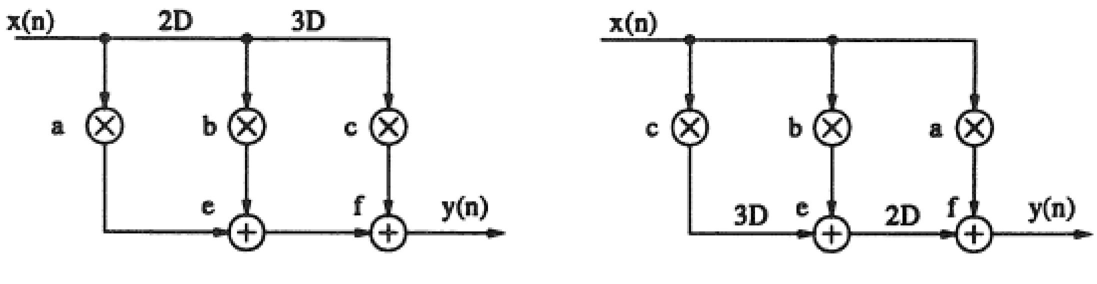
Fig. 4.1 The 3-unfolded DFG for Problem 1(a).

(b). The 4-unfolded DFG is as shown in Figure 4.2.



Chapter 5- Exercise 14

Exercise 14. The DFGs of the direct-form and data broadcast form FIR filter are shown in Figure 4.11(a) and (b), respectively.



(a) (b)

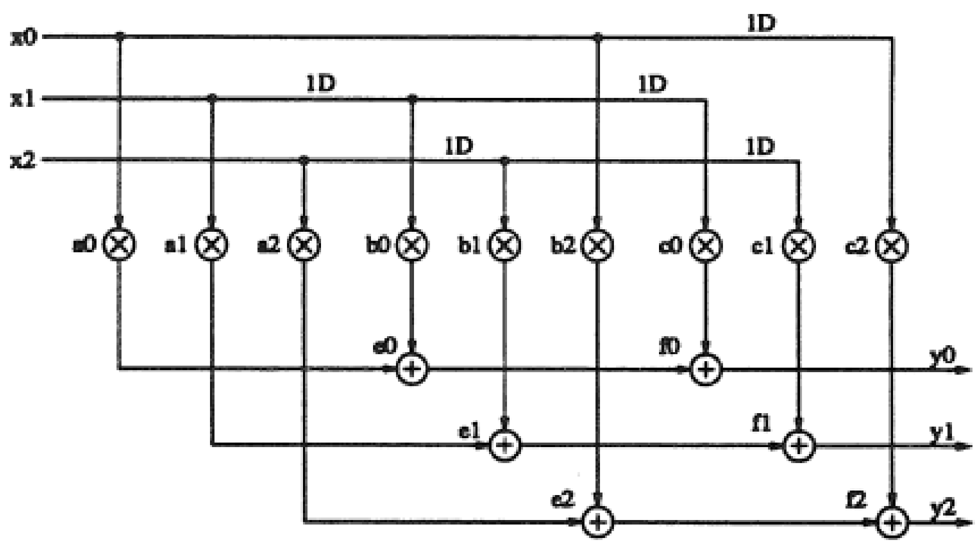


Fig. 4.12 The 3-unfolded DFG for the direct-form FIR filter in Problem 13.

Chapter 6- Exercise 1

. Assuming each MA is pipelined by 1 stage,

$$D_F(x \to MA0) = 2 \times 0 + 0 - 0 - 0 = 0 \quad (6.1)$$

$$D_F(x \to MA1) = 1 \quad (6.2)$$

$$D_F(MA0 \to MA1) = 2 \times 1 + 1 - 0 - 1 = 2 \quad (6.3)$$

$$D_F(MA1 \to MA2) = 2 \times 1 + 0 - 1 - 1 = 0 \quad (6.4)$$

$$D_F(MA2 \to MA3) = 2 \times 1 + 1 - 0 - 1 = 2 \quad (6.5)$$

$$D_F(MA3 \to MA4) = 2 \times 1 + 0 - 1 - 1 = 0 \quad (6.6)$$

$$D_F(MA4 \to MA5) = 2 \times 1 + 1 - 0 - 1 = 2 \quad (6.7)$$

$$D_F(MA5 \to MA6) = 2 \times 1 + 0 - 1 - 1 = 0 \quad (6.8)$$

$$(6.9)$$

The folded structure is as following:

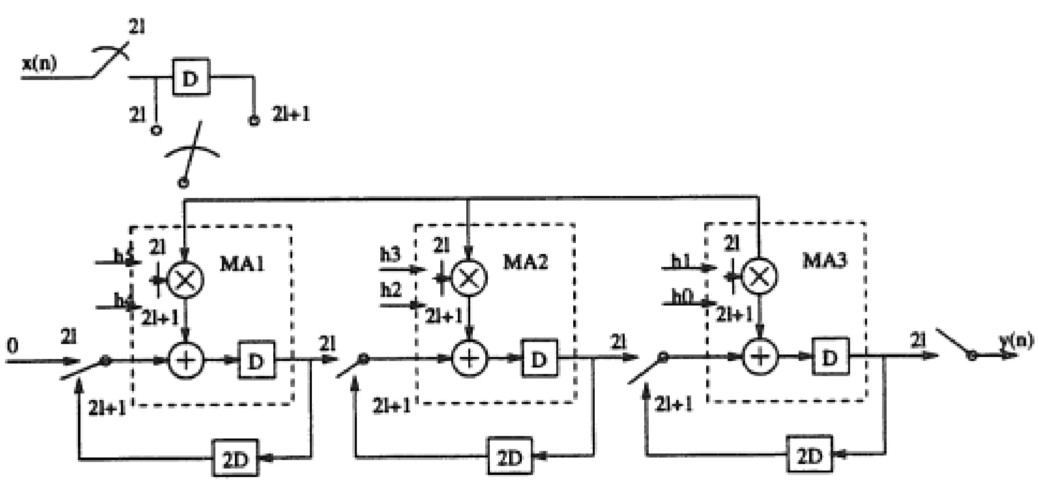


Fig. 6.1 The folded graph for problem 1(a).

(b).

Cycle	In \ Out	MA1/2	MA3/4	MA5/6
0	x0	h5x0	h3x0	h1x0
1	x0	h4x0+h4x(-1)	h2x0+h3x(-1)	h0xo+h1x(-1)
2	x1	h5x1	h3x1+h4x0+h5x(-1)	h1x1+h2x0+h3x(-1)
3	x1	h4x1+h5x0	h2x1+h3x0	h0x1+h1x0
4	x2	h5x2	h3x2+h4x1+h5x0	h1x2+h2x1+h3x0
5	x2	h4x2+h5x1	h2x2+h3x1+h4x0+h5x(-1)	h0x2+h1x1+h2x0+h3x(-1)
6	x3	h5x3	h3x3+h4x2+h5x1	h1x3+h2x2+h3x1+h4x0+h5x(-1)
7	x3	h4x3+h5x2	h2x3+h3x2+h4x1+h5x0	h0x3+h1x2+h2x1+h3x0
8	x4	h5x4	h3x4+h4x3+h5x2	h1x4+h2x3+h3x2+h4x1+h5x0
9	x4	h4x4+h5x3	h2x4+h3x3+h4x2+h5x1	h0x4+h1x3+h2x2+h3x1+h4x0+h5x(-1)=y4
10	x5	h5x5	h3x5+h4x4+h5x3	h1x5+h2x4+h3x3+h4x2+h5x1
11	x5	h4x5+h5x4	h2x5+h3x4+h4x3+h5x2	h0x5+h1x4+h2x3+h3x2+h4x1+h5x0=y5

Chapter 6- Exercise 18

Exercise 18 The golded delay edges are as in the following table:

$$D_{A1\to A2} = 0 - 1 + 3 - 2 = 0$$
$$D_{A2\to A4} = 4 \times 1 - 1 + 1 - 3 = 1$$
$$D_{A2\to M1} = 4 \times 1 - 1 + 0 - 3 = 0$$
$$D_{A2\to M3} = 4 \times 1 - 1 + 2 - 3 = 2$$
$$D_{A2\to M2} = 4 \times 1 - 1 + 1 - 3 = 1$$
$$D_{A2\to M4} = 4 \times 1 - 1 + 3 - 3 = 3$$
$$D_{A3\to A4} = 0 - 1 + 1 - 0 = 0$$
$$D_{M1\to A1} = 0 - 2 + 2 - 0 = 0$$
$$D_{M2\to A1} = 4 \times 1 - 2 + 2 - 1 = 3$$
$$D_{M3\to A3} = 4 \times 1 - 2 + 2 - 1 = 0$$
$$D_{M4\to A3} = 4 \times 1 - 2 + 2 - 1 = 3$$

The folded architecture is shown in Figure 6.40. Unfold it, we get the delay element numbers and switch intervals in Table 6.7. Unfolded structure is the same as original one.