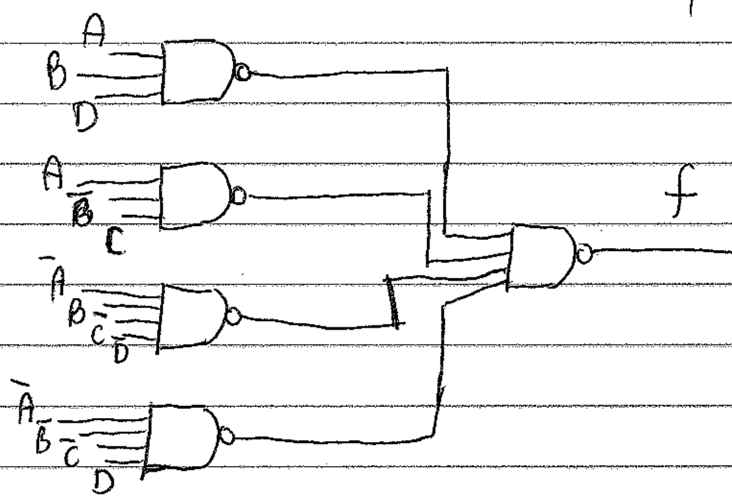
Sheet 1

1- a $f(A,B,C,D) = \sum m(1,4,10,11,13,15)$

CD \ AB	00	01	11	10
00	0: 0	4: 1	12: 0	8: 0
01	1: 1	5: 0	13: 1	9: 0
11	3: 0	7: 0	15: 1	11: 1
10	2: 0	6: 0	14: 0	10: 1

$f = ABD + A\bar{B}C + \bar{A}B\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D$

$f = \overline{\overline{ABD}\cdot\overline{A\bar{B}C}\cdot\overline{\bar{A}B\bar{C}\bar{D}}\cdot\overline{\bar{A}\bar{B}\bar{C}D}}$



b- $f = \overline{\overline{A\bar{C}D}\cdot\overline{\bar{A}\bar{B}D}\cdot\overline{\bar{A}B\bar{C}\bar{D}}\cdot\overline{A\bar{B}C\bar{D}}}$

c- $f = \overline{\overline{\bar{B}\bar{C}D}\cdot\overline{A\bar{B}\bar{D}}\cdot\overline{ABCD}}$

d- $f(A,B,C,D,E) = \sum m(1,3\text{-}7,11,14\text{-}17,22,24\text{-}27,30)$

DE \ ABC	000	001	011	010	100	101	111	110
00	0	4: 1	12	8	16: 1	20	28	24: 1
01	1: 1	5: 1	13	9	17: 1	21	29	25: 1
11	3: 1	7: 1	15: 1	11: 1	19	23	31	27: 1
10	2	6: 1	14: 1	10	18	22: 1	30: 1	26: 1

$f = \overline{\overline{AB\bar{C}}\cdot\overline{A\bar{B}C}\cdot\overline{\bar{A}DE}\cdot\overline{A\bar{C}\bar{D}}\cdot\overline{CD\bar{E}}\;\overline{\bar{A}\bar{B}E}}$

2 a. Group Zeros in such a way you get $\bar f$ or f as follows:

$$\bar f = \bar A C + A B \bar D + A \bar B \bar C + \bar A B D + \bar A \bar B \bar D$$

$$f = (A+\bar C)\cdot(\bar A+\bar B+D)\cdot(\bar A+B+C)\cdot(A+\bar B+\bar D)\cdot(A+B+D)$$

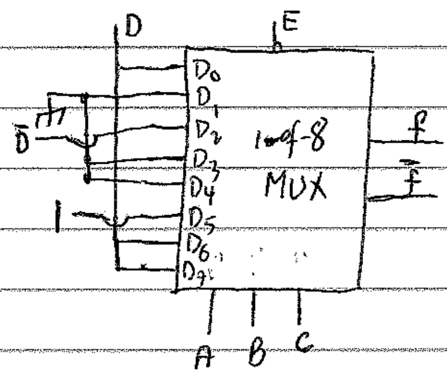
$$\bar{\bar f} = \overline{\overline{(A+\bar C)} + \overline{(\bar A+\bar B+D)} + \overline{(\bar A+B+C)} + \overline{(A+\bar B+\bar D)} + \overline{(A+B+D)}}$$

b- $f = \overline{\overline{\bar B+\bar C} + \overline{A+B+D} + \overline{\bar A+C+D} + \overline{A+\bar B+\bar D} + \overline{\bar A+\bar C+\bar D}}$

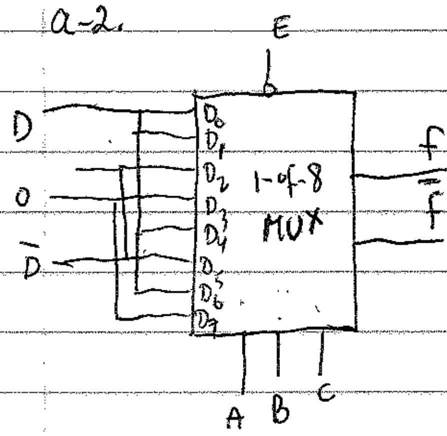
c- $f = \overline{\overline{\bar B+C} + \overline{A+\bar C} + \overline{\bar B+D} + \overline{A+D} + \overline{A+\bar B+\bar D} + \overline{\bar A+\bar C+\bar D}}$

d- $f = \overline{\overline{A+C+E} + \overline{A+B+D} + \overline{\bar A+\bar C+\bar E} + \overline{\bar A+\bar C+D} + \overline{\bar A+B+C+\bar D}}$

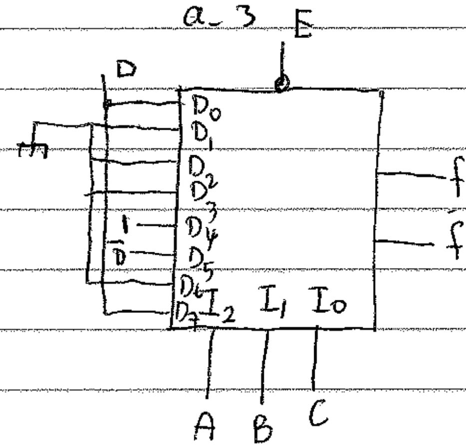
3 a-1. $f(A,B,C,D) = \bar A\bar B\bar C D + \bar A\bar B C(0) + \bar A B\bar C(\bar D) + \bar A B C(0) + A\bar B\bar C(0)$
$+ A\bar B C(1) + AB\bar C(D) + ABC(D)$



a-2.

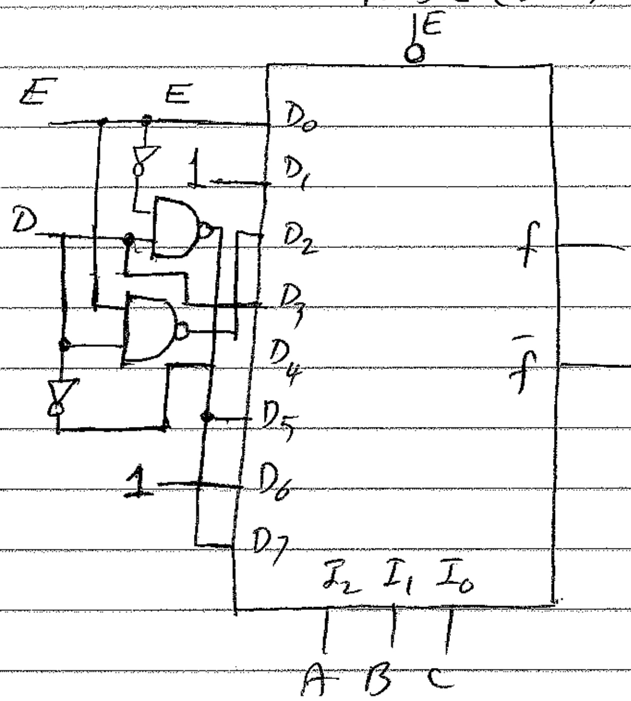


a-3



a- ~~b~~

$$f(A,B,C,D,E) = AB\bar{C} + \bar{A}\bar{B}C + \bar{A}DE + A\bar{C}\bar{D} + CD\bar{E} + \bar{A}\bar{B}E$$
$$= \bar{A}\bar{B}\bar{C}(DE+E) + \bar{A}\bar{B}C(1+E+D\bar{E}) +$$
$$\bar{A}B\bar{C}(DE) + \bar{A}BC(DE+D\bar{E}) + A\bar{B}\bar{C}(\bar{D}) +$$
$$A\bar{B}C(D\bar{E}) + AB\bar{C}(1) + ABC(D\bar{E})$$

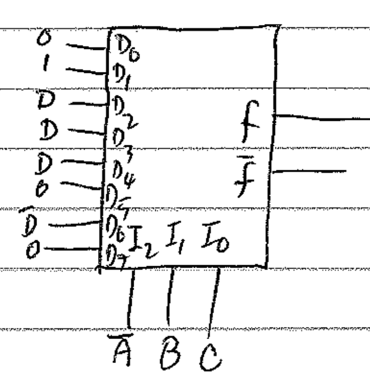


0	E
1	1
2	DE
3	D
4	$\bar{D}$
5	$D\bar{E}$
6	1
7	$D\bar{E}$

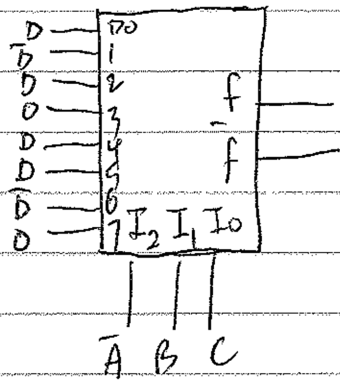
3 b-1 We assume that A is available in complemented form $\bar{A}$.

Therefore, we have to rearrange the function f as follows

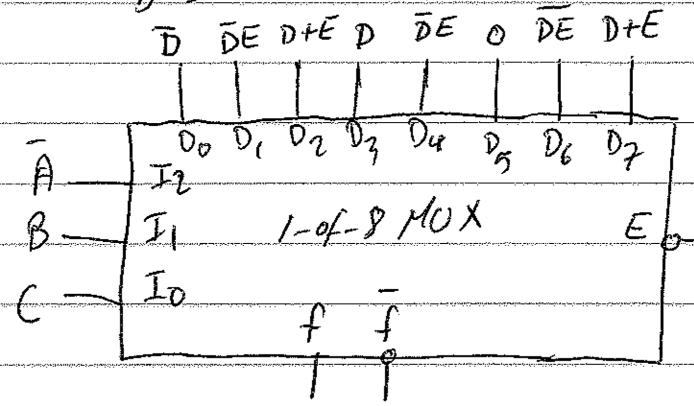
$$f = A\bar{B}\bar{C}(0)$$
$$A\bar{B}C(1)$$
$$AB\bar{C}(D)$$
$$ABC(D)$$
$$\bar{A}\bar{B}\bar{C}(D)$$
$$\bar{A}\bar{B}C(0)$$
$$\bar{A}B\bar{C}(\bar{D})$$
$$\bar{A}BC(0)$$



b-2

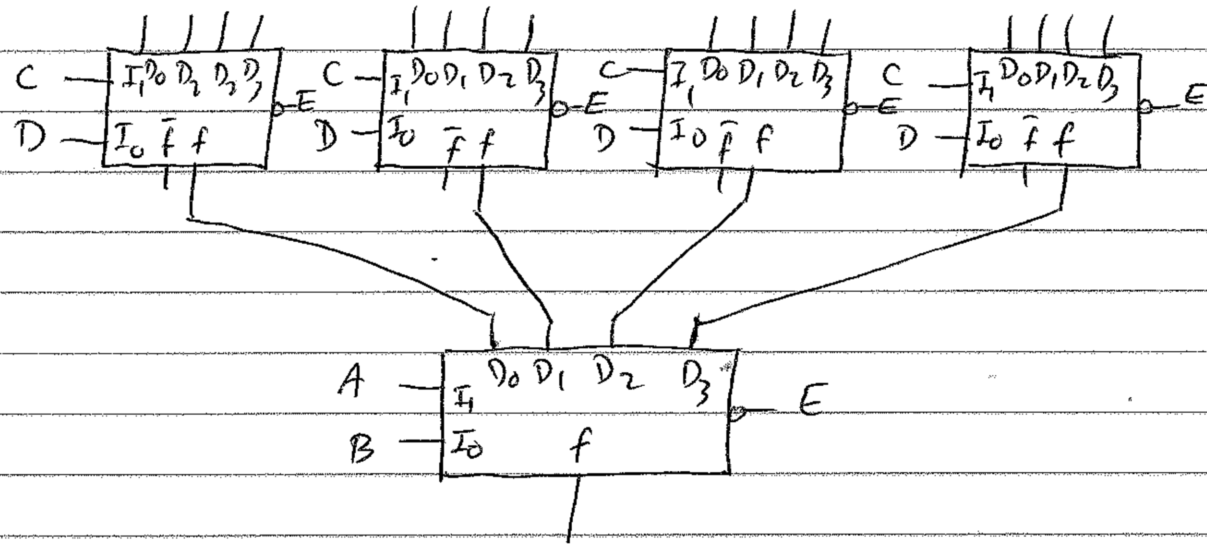


b-5



4a

$$
\begin{aligned}
f = {} & \bar A\bar B[\bar C\bar D(0) + \bar C D(1) + C\bar D(0) + CD(0)] + \\
& \bar A B[\bar C\bar D(1) + \bar C D(0) + C\bar D(0) + CD(0)] + \\
& A\bar B[\bar C\bar D(0) + \bar C D(0) + C\bar D(1) + CD(1)] + \\
& AB[\bar C\bar D(0) + \bar C D(1) + C\bar D(0) + CD(1)]
\end{aligned}
$$



4-d

$$
\begin{aligned}
f = {} & \bar A\bar B[\bar C\bar D(E) + \bar C D(E) + C\bar D(1) + CD(1)] + \\
& \bar A B[\bar C\bar D(0) + \bar C D(E) + C\bar D(0) + CD(1)] + \\
& A\bar B[\bar C\bar D(1) + \bar C D(0) + C\bar D(0) + CD(\bar E)] + \\
& AB[\bar C\bar D(1) + \bar C D(1) + C\bar D(0) + CD(\bar E)]
\end{aligned}
$$

5- $f = \bar{X}\bar{Y}\,[\bar{Z}\bar{U}(1) + \bar{Z}U(0) + Z\bar{U}(0) + ZU(1)] +$

$\bar{X}Y[\bar{Z}\bar{U}(V) + \bar{Z}U(0) + Z\bar{U}(1) + ZU(V)] +$

$X\bar{Y}[\bar{Z}\bar{U}(0) + \bar{Z}U(\bar{V}) + Z\bar{U}(\bar{V}) + ZU(\bar{V})] +$

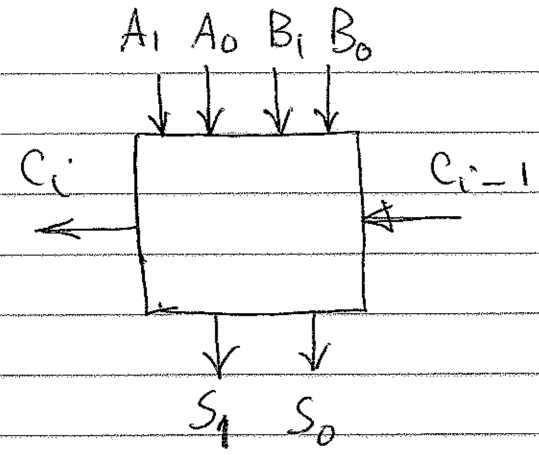
$XY[\bar{Z}\bar{U}(1) + \bar{Z}U(\bar{V}) + Z\bar{U}(\bar{V}) + ZU(0)]$

Sheet #2

1-

A_1	A_0	B_1	B_0	C_{i-1}	C_i	S_1	S_0
0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	1
0	0	0	1	0	0	0	1
0	0	0	1	1	0	1	0
0	0	1	0	0	0	1	0
0	0	1	0	1	0	1	1
0	0	1	1	0	0	1	1
0	0	1	1	1	1	0	0
0	1	0	0	0	0	0	1
0	1	0	0	1	0	1	0
0	1	0	1	0	0	1	0
0	1	0	1	1	0	1	1
0	1	1	0	0	0	1	1
0	1	1	0	1	1	0	0
0	1	1	1	0	1	0	0
0	1	1	1	1	1	0	1
1	0	0	0	0	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	0	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	0	1	0	0
1	0	1	0	1	1	0	1
1	0	1	1	0	1	0	1
1	0	1	1	1	1	1	0
1	1	0	0	0	0	1	1
1	1	0	0	1	1	0	0
1	1	0	1	0	1	0	0
1	1	0	1	1	1	0	1
1	1	1	0	0	1	0	1
1	1	1	0	1	1	1	0
1	1	1	1	0	1	1	0
1	1	1	1	1	1	1	1

This is a combinational circuit of five inputs A_1, A_0, B_1, B_0 and C_{i-1} and three outputs S_1, S_0, and C_i



Using K-map for minimization

B_0C_{i-1} \ $A_1A_0B_1$	000	001	011	010	110	111	101	100
00						1	1	
01			1		1	1	1	
11		1	1		1	1	1	1
10			1		1	1	1	

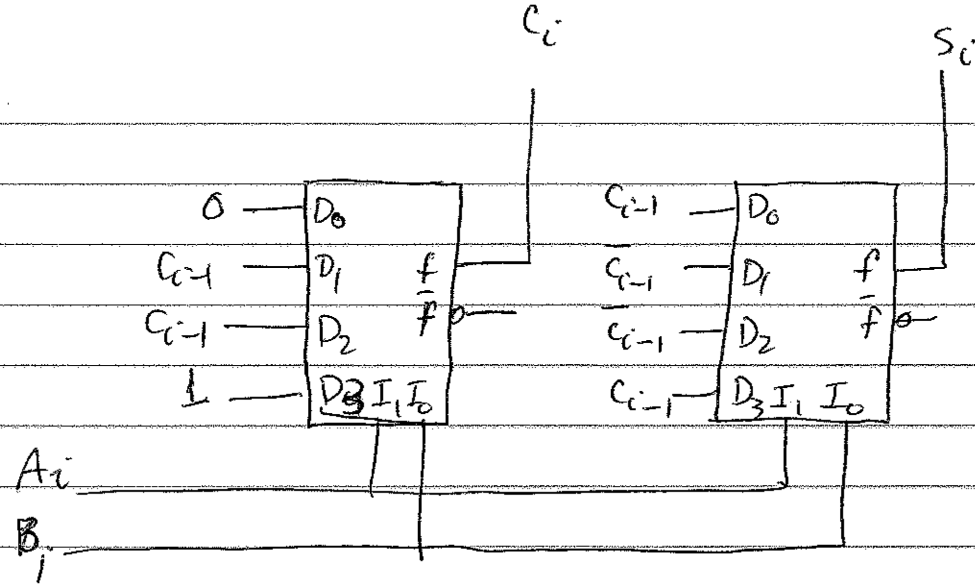
$$C_i = A_1B_1 + A_1B_0C_{i-1} + A_1A_0C_{i-1} + A_1A_0B_0 + A_0B_1C_{i-1} + B_1B_0C_{i-1} + A_0B_1B_0$$

Semilarly

$$S_1 = A_1A_0B_1\bar{B}_0 + A_1\bar{A}_0\bar{B}_1\bar{B}_0 + \bar{A}_1A_0\bar{B}_1B_0 + A_1A_0B_1B_0 + \bar{A}_1\bar{A}_0B_1C_{i-1} + \bar{A}_1B_1\bar{B}_0\bar{C}_{i-1} + \bar{A}_1\bar{B}_1B_0C_{i-1} + A_1\bar{A}_0\bar{B}_1C_{i-1} + A_1B_1B_0C_{i-1} + A_1A_0B_1C_{i-1} + A_1\bar{B}_1\bar{B}_0C_i$$

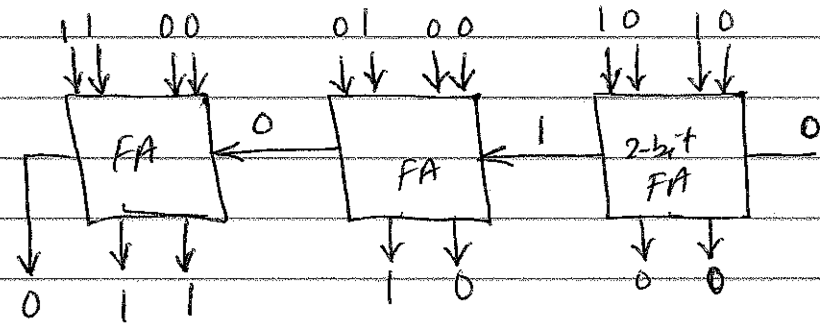
$$S_0 = A_0 \oplus B_0 \oplus C_{i-1}$$

2-



3- Figure 5-5b from the text

4-



1 1 0

0 0 0 0 1 0

1 1 0 1 1 0

1 1 1 0 0 0

carry 0 carry 0 carry 1 carry 0

Sheet 4

Chapter 6:

1.

$z \backslash xy$	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$S(t+\Delta t)$

$x(t)$	$y(t)$	$z(t)$	$S(t+\Delta t)$	$C_o(t+\Delta t)$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$$S(t+\Delta t) = \bar{z}(\bar{x}y + x\bar{y}) + z(\bar{x}\bar{y} + xy)$$
$$= x \oplus y \oplus z$$

$z \backslash xy$	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$C_o(t+\Delta t)$

$C_o(t+\Delta t) = xy + z(x \oplus y)$ Bridging technique

2. $J_1 = 1 \cdot Q_2 = Q_2$

$K_1 = 1$

$J_2 = Q_1$

$K_2 = \bar{Q}_1$

For an initial value of $Q_1 = 0$, $Q_2 = 0$

$J_1K_1 = 01$ resets FF_1, allready reset

$J_2K_2 = 01$ resets FF_2, allready reset

So, both FFs are remained the same at zero, zero

3.

PS	$\bar{Q}_3$	1	1	$Q_1 \oplus Q_3$	$\overline{Q_2 \cdot K_2}$	$Q_1 + \bar{Q}_2$	NS
$Q_3Q_2Q_1$	J_1	K_1	J_2	K_2	J_3	K_3	$Q_3Q_2Q_1$
0 0 1	1	1	1	1	1	1	1 1 0
1 1 0	0	1	1	1	0	0	1 0 0
1 0 0	0	1	1	1	1	1	0 1 0
0 1 0	1	1	1	0	1	0	0 1 0
1 1 1	0	1	1	0	1	1	0 1 0

$001 \rightarrow 110 \rightarrow 100 \rightarrow 010 \rightarrow 111 \rightarrow 010 \rightarrow 111 \rightarrow 010 \ldots\ldots$

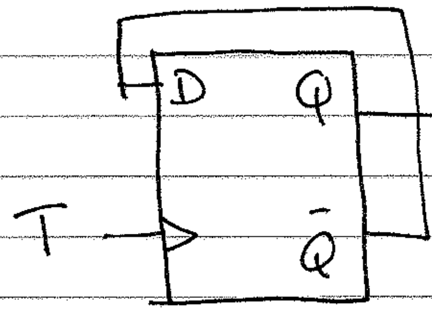
4.

$Q = D$ clock high

Q = as is T-low

$Q \to$ toggles T high

So we can feed $\bar{Q}$ to D to result in Q if T is used as a clock

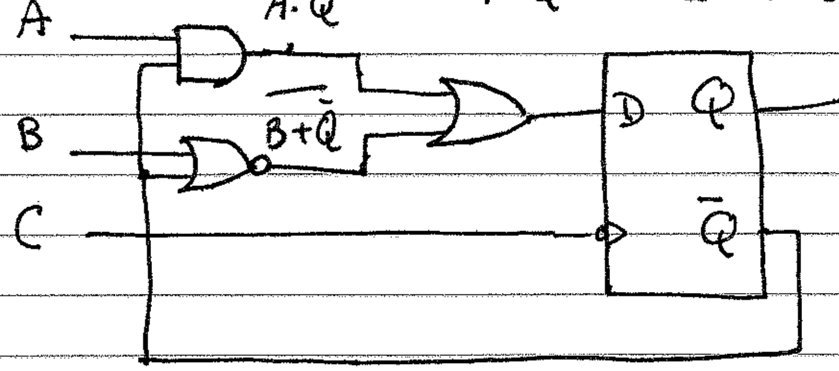


$Q = D$

T is high

5.

$A.\bar{Q} + \overline{(B+\bar{Q})} = A.\bar{Q} + \bar{B}Q$



$Q = A\bar{Q} + \bar{B}Q$

Comparing this equation to the equation of a JK FF

$$Q = J\bar{Q} + \bar{K}Q$$

So, the circuit, using a D FF, is performing the function of a JK FF.

6.

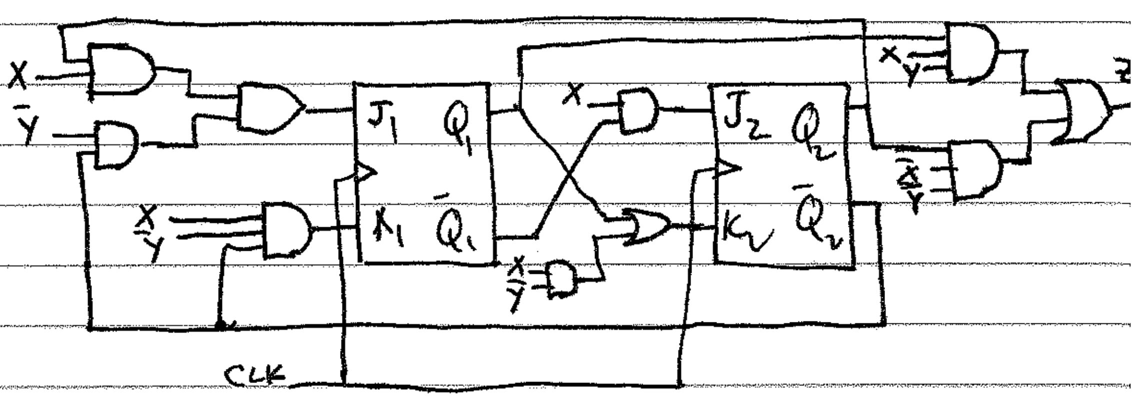
$J_1 = XQ_2 + \bar{Y}\bar{Q}_2$

$K_1 = X\bar{Y}Q_2$

$J_2 = \bar{X}Q_1$

$K_2 = X\bar{Y} + Q_1$

$Z = XYQ_1 + \bar{X}\bar{Y}Q_2$



State equations: $Q = J\bar{Q} + \bar{K}Q$.

Sheet 5

chapter 7:

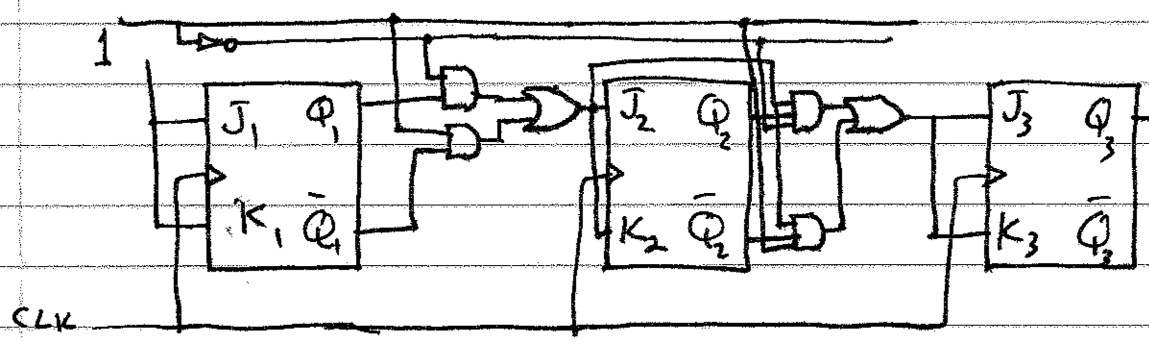
1. Three bit counter $Q_3 Q_2 Q_1$ $E=1$ down
$E=0$ up

so, $J_n = K_n = \bar{E} J_{n-1} Q_{n-1} + E J_{n-1} \bar{Q}_{n-1}$

$J_1 = K_1 = 1$

$J_2 = K_2 = \bar{E} Q_1 + E \bar{Q}_1$

$J_3 = K_3 = \bar{E} J_2 Q_2 + E J_2 \bar{Q}_2$



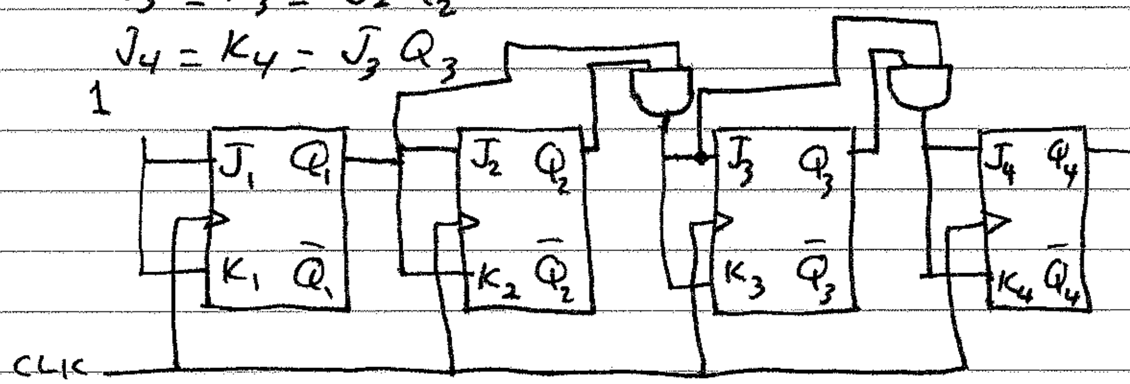
2. Four-bit up counter

$J_1 = K_1 = 1$

$J_2 = K_2 = Q_1$

$J_3 = K_3 = J_2 Q_2$

$J_4 = K_4 = J_3 Q_3$

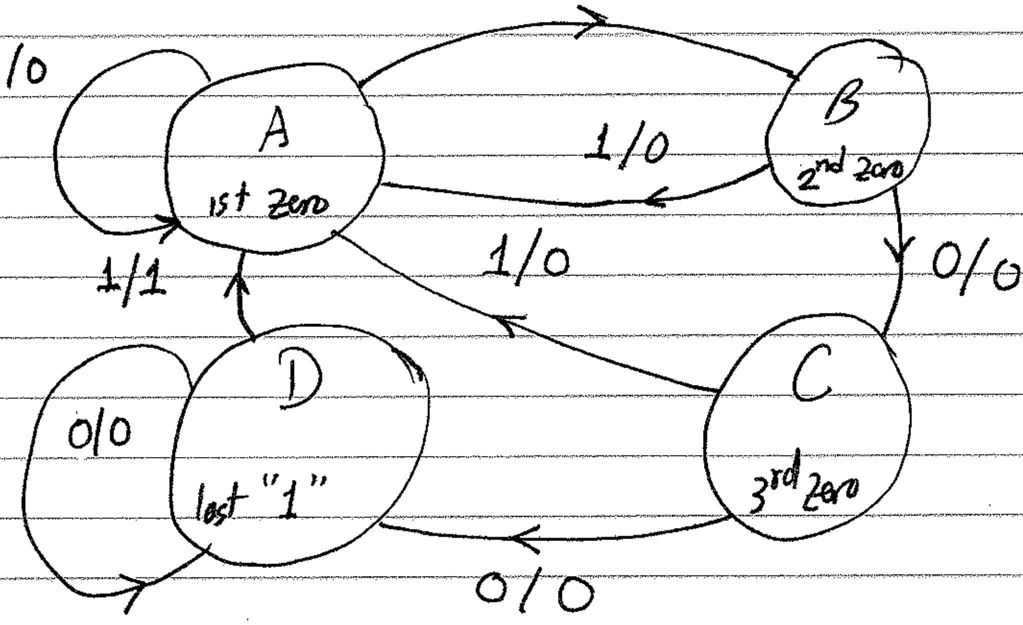


3. The number of states in the required sequential circuits is equal to the number of bits in the given streams of bits

a, b, c, and d requires four states

e, f, and g requires five while h requires six.

a. stream 0 0 0 1



state-table

$PS\ Q_2Q_1$	NS, z: $x=0$	NS, z: $x=1$
A (00)	B, 0	A, 0
B (01)	C, 0	A, 0
C (11)	D, 0	A, 0
D (10)	D, 0	A, 1

transition table

$PS\ Q_2Q_1$	NS, z: $x=0$	NS, z: $x=1$
00	01	00
01	11	00
11	10	00
10	10	00, 1

$z = Q_2\,\bar{Q}_1\,x \cdot CLK$

$x \backslash Q_2Q_1$	00	01	11	10
0	1 0	– 0	0 1	0 –
1	0 –	0 1	0 1	0 –

S_1R_1

$S_1 = \bar{x} \cdot \bar{Q}_2$

$R_1 = x + Q_2$

$x \backslash Q_2Q_1$	00	01	11	10
0	0 –	1 0	– 0	– 0
1	0 –	0 –	0 1	0 1

S_2R_2

$S_2 = \bar{x}\,Q_1$

$R_2 = x$

You can continue the same way except for increasing an additional state in e, f, and g, and two additional states in h.

4. JK

Z stands still: $Z = Q_2\bar{Q}_1\, x \cdot CLK$

$x \backslash Q_2Q_1$	00	01	11	10
0	1_	_0	_1	0_
1	0_	_1	_1	0_

J_1K_1

$J_1 = \bar{x} \cdot \bar{Q}_2$

$K_1 = x + Q_2$

$x \backslash Q_2Q_1$	00	01	11	10
0	0_	1_	_0	_0
1	0_	0_	_1	_1

J_2K_2

$J_2 = \bar{x} Q_1$

$K_2 = x$

5. T-FF

Z stands still $Z = Q_2\bar{Q}_1 x \cdot CLK$

$x \backslash Q_2Q_1$	00	01	11	10
0	1	0	1	0
1	0	1	1	0

$T_1 = xQ_1 + \bar{x}\bar{Q}_2\bar{Q}_1 + Q_1Q_2$

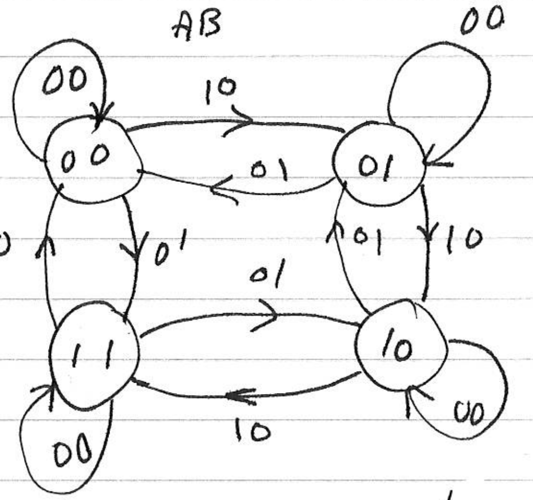
$= xQ_1 + \bar{x}\bar{Q}_2\bar{Q}_1 + Q_2Q_1$

$x \backslash Q_2Q_1$	00	01	11	10
0	0	1	0	0
1	0	0	1	1

$T_1 = xQ_2 + \bar{x}\bar{Q}_2Q_1$

6.

PS Q_2Q_1	NS 00	NS 01	NS 10
00	00	11	01
01	01	00	10
10	10	01	11
11	11	10	00



$AB \backslash Q_2Q_1$	00	01	11	10
00	0_	_0	0_	_0
01	1_	_1	_1	1_
11	--	--	--	--
10	1_	_1	_1	1_

J_1K_1

$AB \backslash Q_2Q_1$	00	01	11	10
00	0_	0_	_0	_0
01	1_	0_	_0	_1
11	--	--	--	--
10	0_	1_	_1	_0

11-never happens

J_2K_2

$$J_1 = B + A$$
$$K_1 = B + A$$

$$J_2 = \bar{Q}_2 \bar{Q}_1 B + A \cdot Q_1$$
$$K_2 = B \bar{Q}_1 + A \cdot Q_1$$

7.