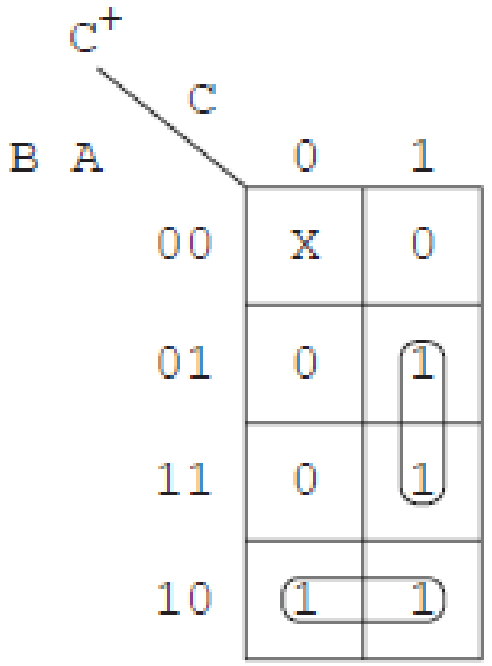
Sequential Circuits

Practice Problems

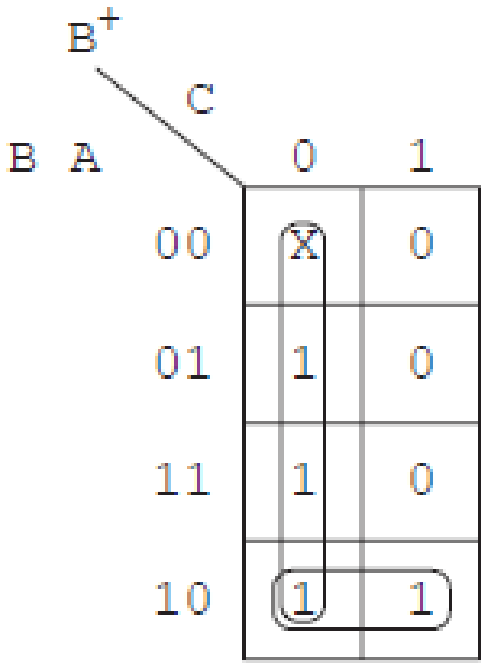
Design a 3-bit counter using D flip-flops which counts in the sequence 001, 011, 010, 110, 111, 101, 100, (repeat), 001, 011, …

What will happen if the counter is started in the state 000?

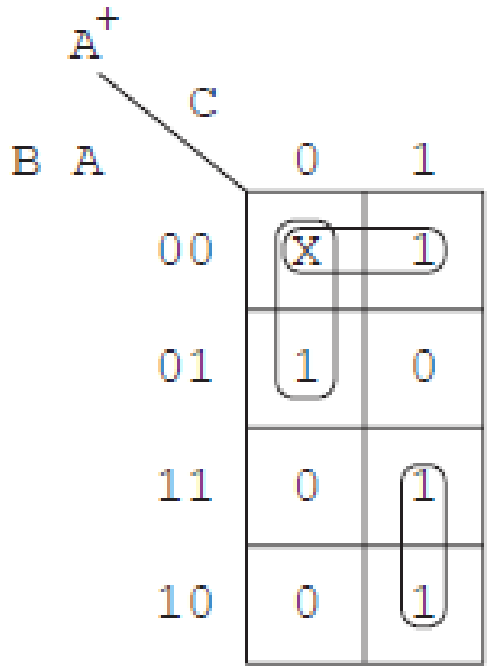
$C\,B\,A$	$C^+B^+A^+$
0 0 0	X X X
0 0 1	0 1 1
0 1 0	1 1 0
0 1 1	0 1 0
1 0 0	0 0 1
1 0 1	1 0 0
1 1 0	1 1 1
1 1 1	1 0 1



$C^+ = C\,A + B\,A'$



$B^+ = C' + B\,A'$

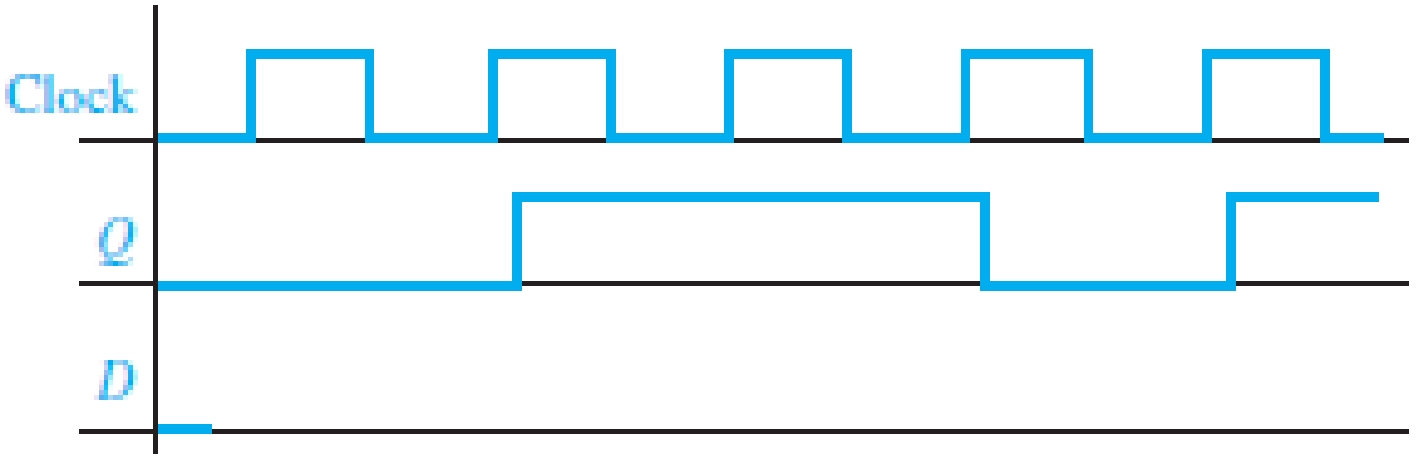


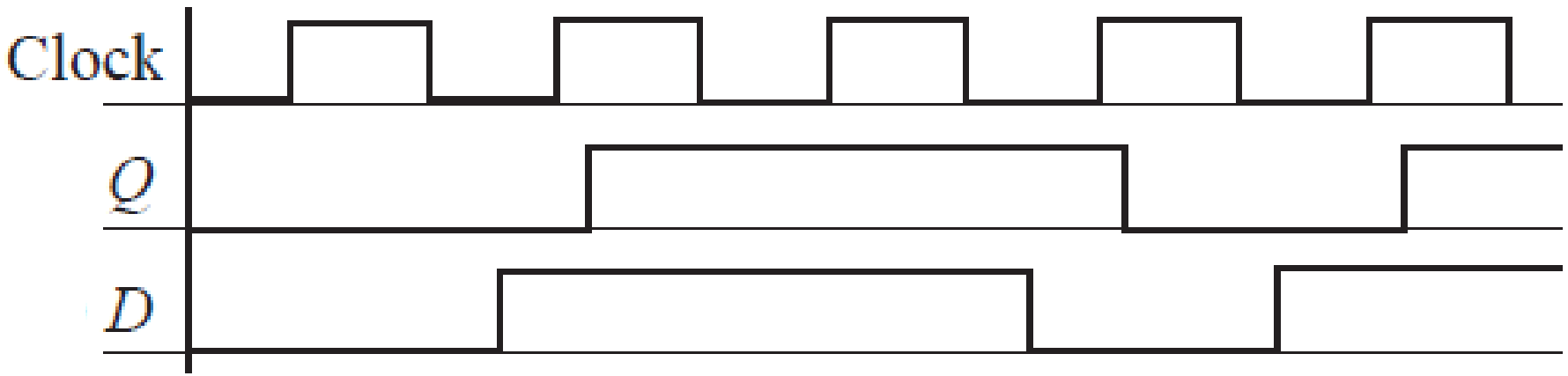
$A^+ = C'B' + C\,B + B'A'$

For D flip-flop: 000 goes to 011 because $D_C D_B D_A = 011$

$A^+ = C'B' + C\,B + C\,A'$

Find the input for a rising-edge-triggered D flip-flop that would produce the output Q as shown. Fill in the timing diagram.



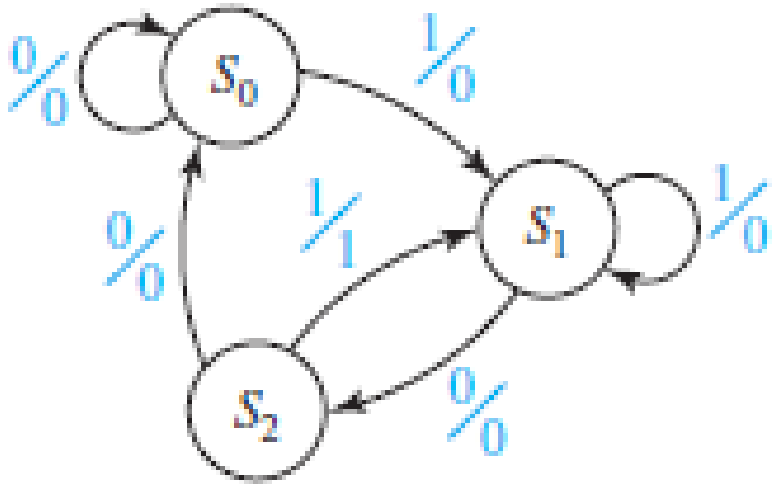

Clock
Q
D

Design problem

- Sequence detector: any input sequence ending with 101 produces output Z = 1 coincident with the last 1

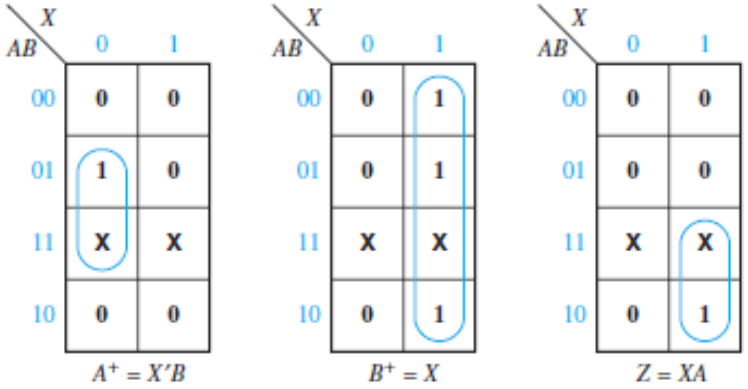
X =	0	0	1	1	0	1	1	0	0	1	0	1	0	1	0	0
Z =	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0
(time:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15)

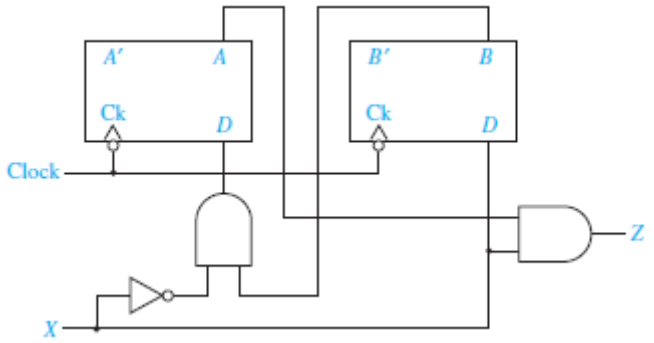
Mealy Machine



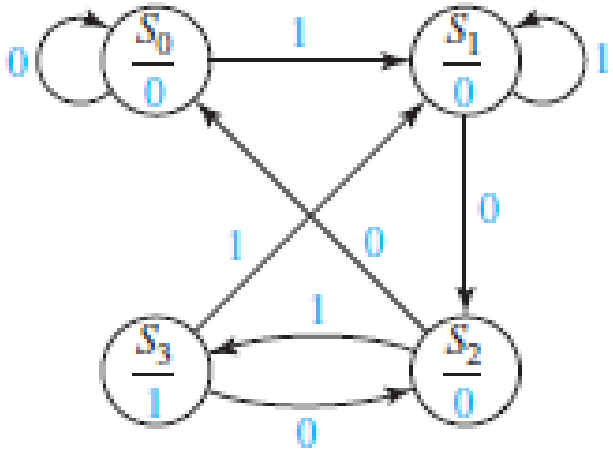
Present State	Next State $X=0$	Next State $X=1$	Present Output $X=0$	Present Output $X=1$
S_0	S_0	S_1	0	0
S_1	S_2	S_1	0	0
S_2	S_0	S_1	0	1

AB	A^+B^+ $X=0$	A^+B^+ $X=1$	Z $X=0$	Z $X=1$
00	00	01	0	0
01	10	01	0	0
10	00	01	0	1





Moore Machine



Present State	Next State $X=0$	Next State $X=1$	Present Output(Z)
S_0	S_0	S_1	0
S_1	S_2	S_1	0
S_2	S_0	S_3	0
S_3	S_2	S_1	1

AB	A^+B^+ $X=0$	A^+B^+ $X=1$	Z
00	00	01	0
01	11	01	0
11	00	10	0
10	11	01	1

Is this Mealy or Moore?