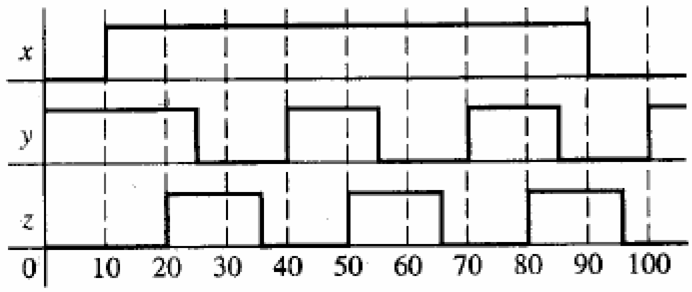
EEC180A DIGITAL SYSTEMS I Winter, 2006.

Solutions for Homework # 5

11.1



Z responds to X and to Y after 10 ns;

Y responds to $\bar{Z}$ after 5 ns.

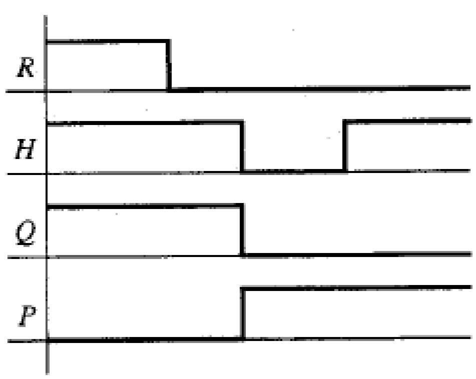
11.2 (a) $R = 1$ and $H = 0$ cannot occur at the same time.

(b)

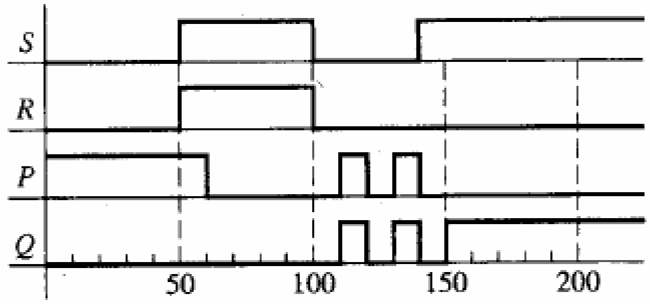
R	H	Q	Q^+
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	X
1	0	1	X
1	1	0	1
1	1	1	1

$Q^+ = R + HQ$

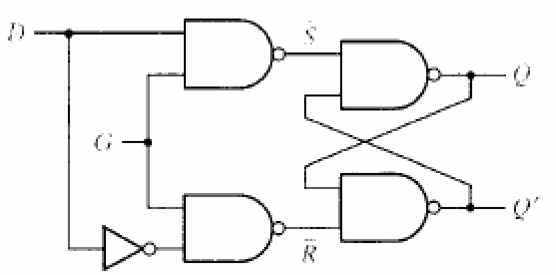
(c)



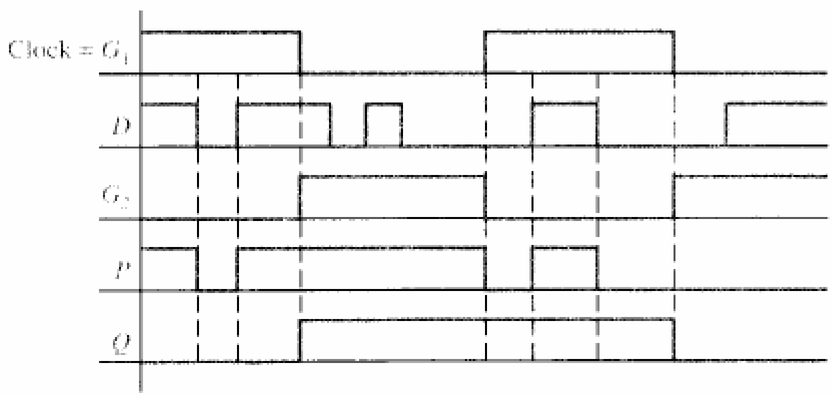
11.3



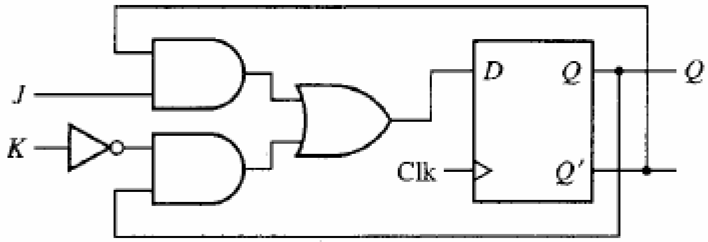
11.4



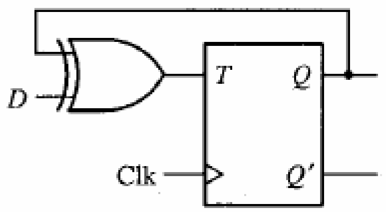
11.5 Connect the clock directly to the input G_1 and connect the clock to G_2 through an inverter.



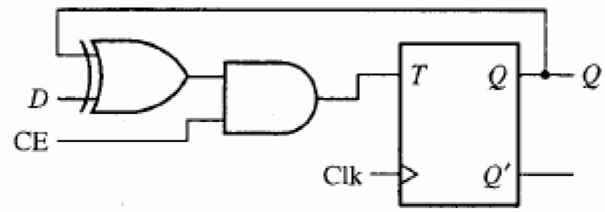
11.10 (a)



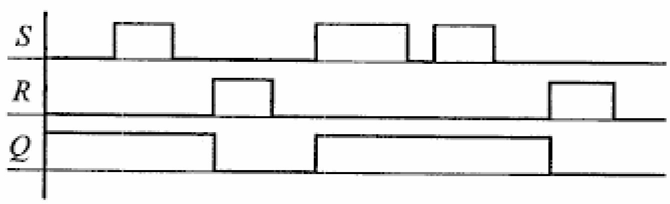
(b)



(c)

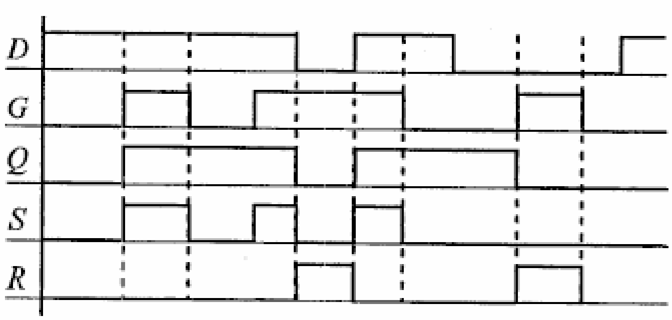


11.11

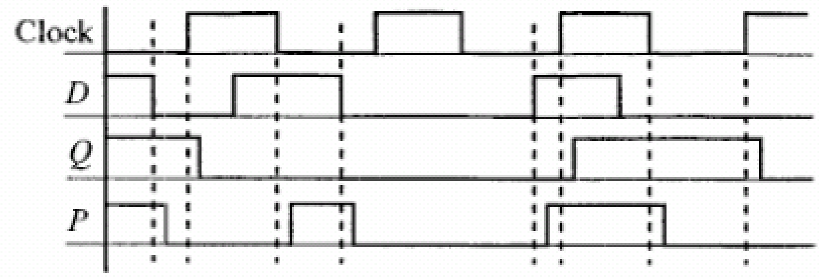


11.12 For every input/state combination with the condition $SR = 0$ holding, each circuit obeys the next-state equation $Q^+ = S + R'Q$. When $S = R = 1$, in (a), both outputs are 1, and in (b), the latch holds its state.

11.13

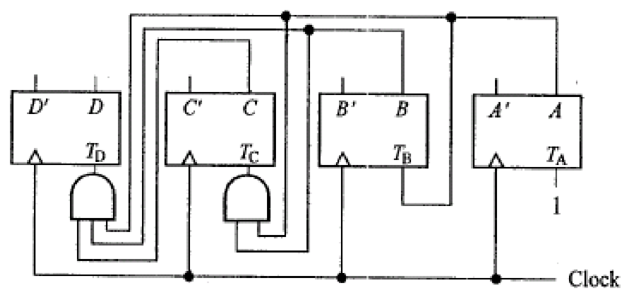


11.14



12.4 (a)

Present State $DCBA$	Next State $D^+C^+B^+A^+$	Flip-Flop Inputs $T_DT_CT_BT_A$
0 0 0 0	0 0 0 1	0 0 0 1
0 0 0 1	0 0 1 0	0 0 1 1
0 0 1 0	0 0 1 1	0 0 0 1
0 0 1 1	0 1 0 0	0 1 1 1
0 1 0 0	0 1 0 1	0 0 0 1
0 1 0 1	0 1 1 0	0 0 1 1
0 1 1 0	0 1 1 1	0 0 0 1
0 1 1 1	1 0 0 0	1 1 1 1
1 0 0 0	1 0 0 1	0 0 0 1
1 0 0 1	1 0 1 0	0 0 1 1
1 0 1 0	1 0 1 1	0 0 0 1
1 0 1 1	1 1 0 0	0 1 1 1
1 1 0 0	1 1 0 1	0 0 0 1
1 1 0 1	1 1 1 0	0 0 1 1
1 1 1 0	1 1 1 1	0 0 0 1
1 1 1 1	0 0 0 0	1 1 1 1



As explained in Section 12.3, it can be seen that A changes on every pulse: $T_A = 1$
B changes only when $A = 1$: $T_B = A$
C changes only when both B and $A = 1$: $T_C = AB$
D changes only when A, B, and $C = 1$: $T_D = ABC$

12.4 (b) The binary counter using D flip-flops is obtained by converting each T flip-flop to a D flip-flop by adding an XOR gate.

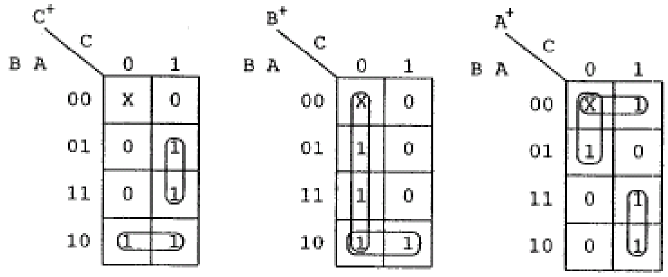
See FLD p. 650 and Figure 12-15 on FLD p. 335.

12.5 Equations for C, B, and A are from Equations (12-2) on FLD p. 335. Beginning with (b) of Problem 12.4 solutions,

$D^+ = D \oplus CBA = D'CBA + D(CBA)'$
$= D'CBA + D(C' + B' + A')$
$= D'CBA + DC' + DB' + DA'$

12.7 (a)

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



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

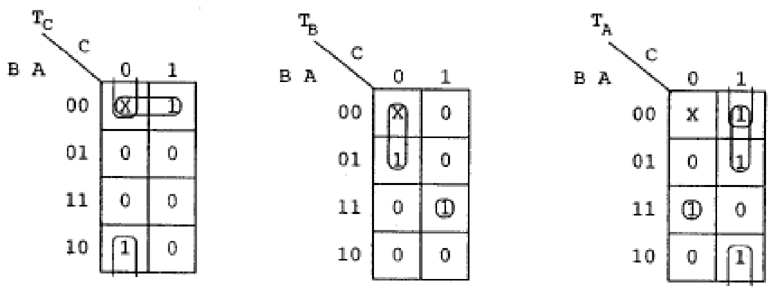
$B^+ = C' + B\,A'$

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

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

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

12.7 (b)



$T_C = C'A' + B'A'$

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

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

For T flip-flop: 000 goes to 110 because $T_A T_B T_C = 110$

12.8 (a)

CBA	$C^+B^+A^+$
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^+

BA \ C	0	1
00	X	0
01	0	1
11	0	1
10	1	1

B^+

BA \ C	0	1
00	X	0
01	1	0
11	1	0
10	1	1

A^+

BA \ C	0	1
00	X	1
01	1	0
11	0	1
10	0	1

J_C

BA \ C	0	1
00	X	X
01	0	X
11	0	X
10	1	X

$J_C = A'$

K_C

BA \ C	0	1
00	X	1
01	X	0
11	X	0
10	X	0

$K_C = B'A'$

J_B

BA \ C	0	1
00	X	0
01	1	0
11	X	X
10	X	X

$J_B = C'$

K_B

BA \ C	0	1
00	X	X
01	X	X
11	0	1
10	0	0

$K_B = C A$

J_A

BA \ C	0	1
00	X	1
01	X	X
11	X	X
10	0	1

$J_A = C$

K_A

BA \ C	0	1
00	X	X
01	0	1
11	1	0
10	X	X

$K_A = C'B + C B'$

In state 000,
$J_C = A' = 1, K_C = B'A' = 1, C^+ = C' = 1$
$J_B = C' = 1, K_B = CA = 0, B^+ = 1$
$J_A = C = 0, K_A = CB' + C'B = 0, A^+ = A = 0$
So the next state is $C^+B^+A^+ = 110$

12.8 (b)

S_C

BA \ C	0	1
00	X	0
01	0	X
11	0	X
10	1	X

$S_C = B A'$

$S_C = C'A'$

R_C

BA \ C	0	1
00	X	1
01	X	0
11	X	0
10	0	0

$R_C = B'A'$

S_B

BA \ C	0	1
00	X	0
01	1	0
11	X	0
10	X	X

$S_B = C'$

R_B

BA \ C	0	1
00	X	X
01	0	X
11	0	1
10	0	0

$R_B = C A$

S_A

BA \ C	0	1
00	X	1
01	X	0
11	0	X
10	0	1

$S_A = C A'$

R_A

BA \ C	0	1
00	X	0
01	0	1
11	1	0
10	X	0

$R_A = C'B + C B'A$

In state 000,
$S_C = BA' = 0, R_C = B'A' = 1, C^+ = 0$
$S_B = C' = 1, R_B = CA = 0, B^+ = 1$
$S_A = CA' = 0, R_A = C'B + C'BA = 0, A^+ = A = 0$
So the next state is $C^+B^+A^+ = 010$