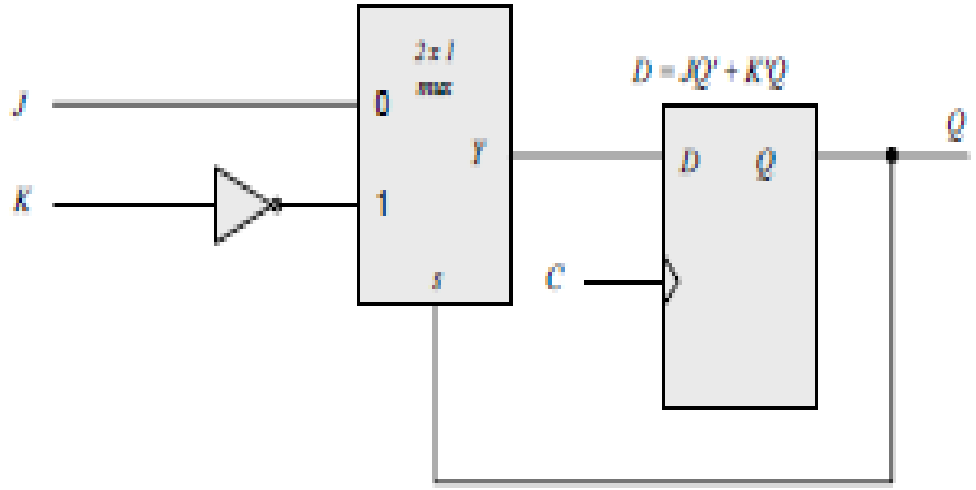
Chapter5-Synchronous Sequential Logic

Lecture8- Problem Solving Session

5-2: Construct a JK flip-flop using a D flip-flop, a two-to-one line multiplexer, and an inverter

Solution:



5-4: A PN flip-flop has four operations, clear to 0, no change, complement, and set to 1, when inputs P and N are 00, 01, 10, and 11 respectively.

a) Tabulate the characteristic table

b) Derive the characteristic equation

c) Tabulate the excitation table

d) Show how the PN flip-flop can be converted to a D flip-flop

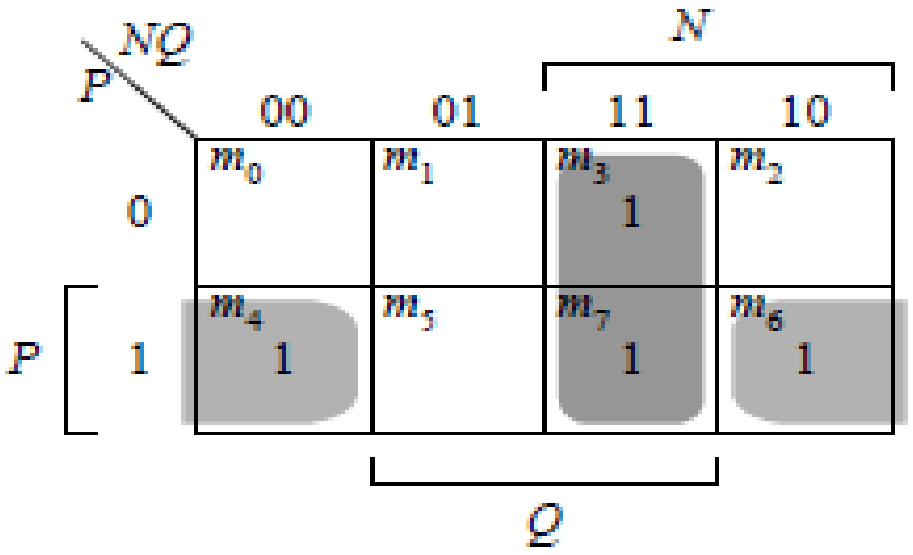
Solution:

(a)

P	N	Q(t + 1)
0	0	0
0	1	$Q(t)$
1	0	$Q'(t)$
1	1	1

(b)

P	N	$Q(t)$	$Q(t + 1)$
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1



$$Q(t+1) = PQ' + NQ$$

(c)

$Q(t)$	$Q(t+1)$	P	N
0	0	0	x
0	1	1	x
1	0	x	0
1	1	x	1

(d) Connect P and N together.

5-8: Derive the state table and the state diagram of the sequential circuit shown in Fig5-8. Explain the function that the circuit performs.

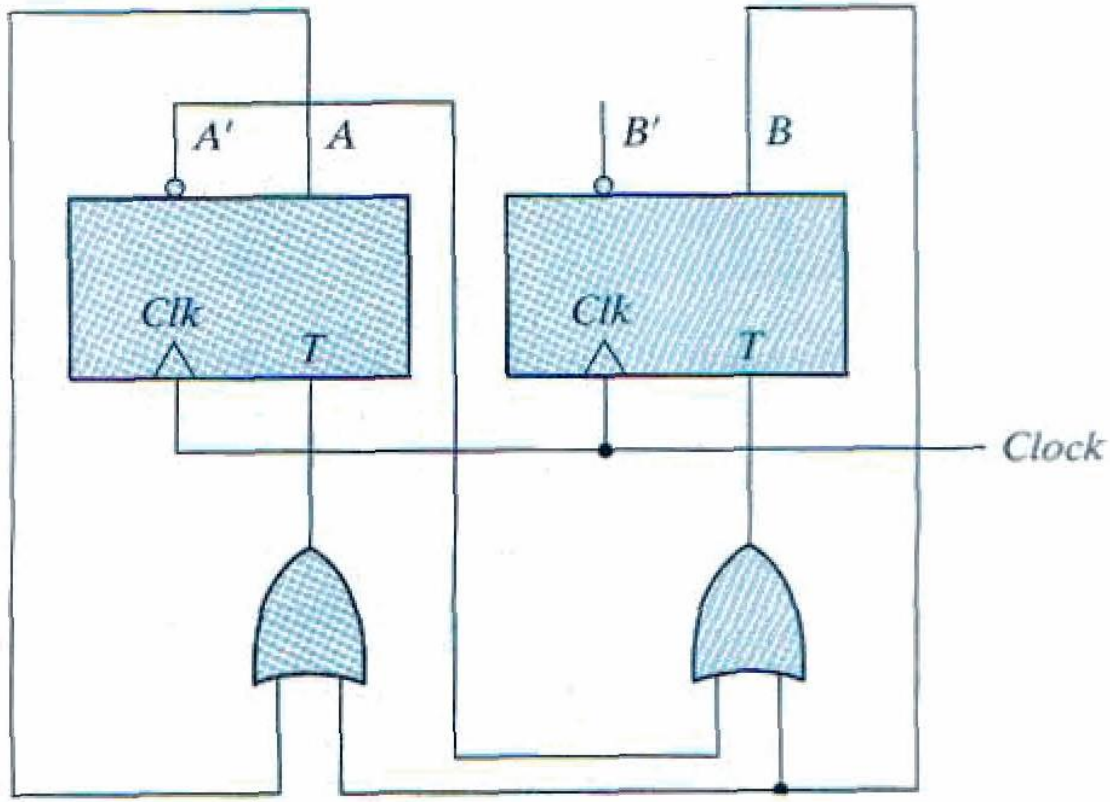


FIGURE P5.8

Solution:

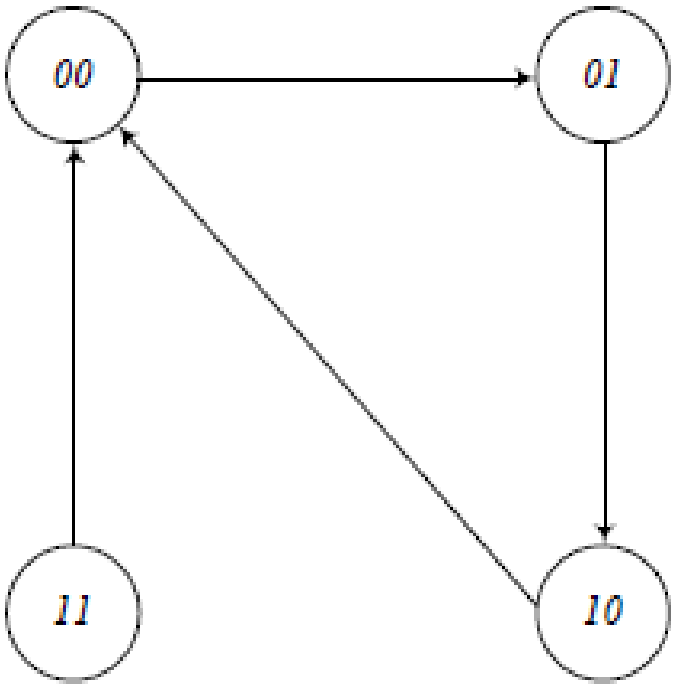
A counter with a repeated sequence of 00, 01, 10.

Present state		Next state		FF Inputs	
A	B	A	B	T_A	T_B
0	0	0	0	0	1
0	1	1	0	1	1
1	0	0	0	1	0
1	1	0	0	1	1

$$T_A = A + B$$
$$T_B = A' + B$$

Repeated sequence:

00 → 01 → 10 →



Problem5-10: A sequential circuit has two JK flip-flops, two inputs x and y, and one output z. The flip-flop input equations and circuit output equations are

$J_A = Bx + B'x'$

$K_A = B'xy'$

$J_B = A'x$

$K_B = A + xy'$

$Z = Ax'y' + Bx'y'$

Solution:

(b)

Present state		Inputs		Next state		Output	FF Outputs			
A	B	x	y	A	B	z	J_A	K_A	J_A	J_B
0	0	0	0	1	0	0	1	0	0	0
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	1	0	1	1	1	1
0	0	1	1	0	1	0	0	0	1	0
0	1	0	0	0	1	1	0	0	0	0
0	1	0	1	0	1	0	0	0	0	0
0	1	1	0	1	0	0	1	0	1	0
0	1	1	1	1	1	0	1	0	1	0
1	0	0	0	1	0	0	1	0	0	1
1	0	0	1	1	0	0	0	0	0	1
1	0	1	0	0	0	0	1	1	0	1
1	0	1	1	1	0	0	0	0	0	1
1	1	0	0	1	0	1	0	0	0	1
1	1	0	1	1	0	0	0	0	0	1
1	1	1	0	1	0	0	1	0	0	1
1	1	1	1	1	0	1	1	0	0	1

(c) State Equations of A and B

$A(t+1)= J_A A' + K_A' A$

$= (Bx+B'y')A' + (B'xy')'A$

$= A'Bx + A'B'y' + AB + Ax' + Ay$

$= Bx + A'B'y' + AB + Ax' + Ay$

$= Bx + A'B'y' + Ax' + Ay$

$B(t+1)= J_B B' + K_B' B$

$= A'xB' + (A+xy')'B$

$= A'B'x + A'Bx' + A'By$

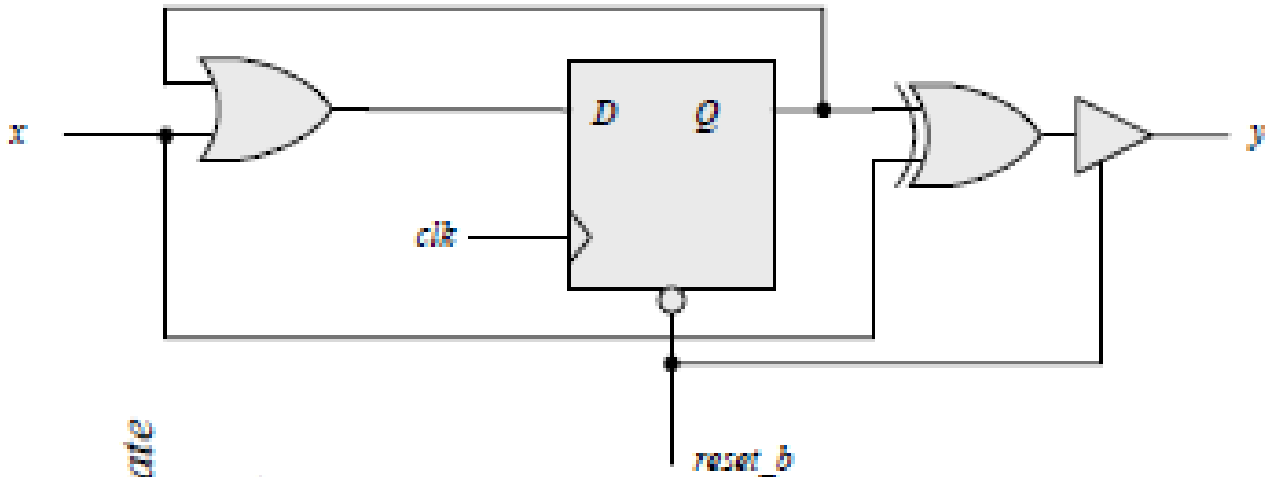
Problem 5-12: Reduce the number of states in the following state table, and tabulate the reduced state table.

	Next State		Output	
Present State	$x = 0$	$x = 1$	$x = 0$	$x = 1$
a	f	b	0	0
b	d	c	0	0
c	f	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	1	1
g	g	h	0	1
h	g	a	1	0

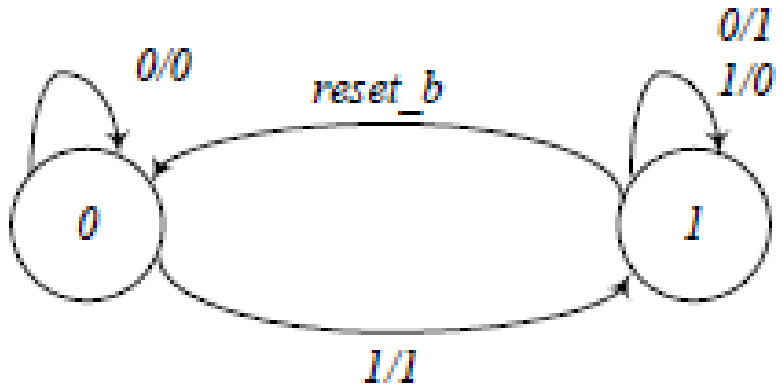
Solution:

Present state	Next state 0	Next state 1	Output 0	Output 1
a	f	b	0	0
b	d	a	0	0
d	g	a	1	0
f	f	b	1	1
g	g	d	0	1

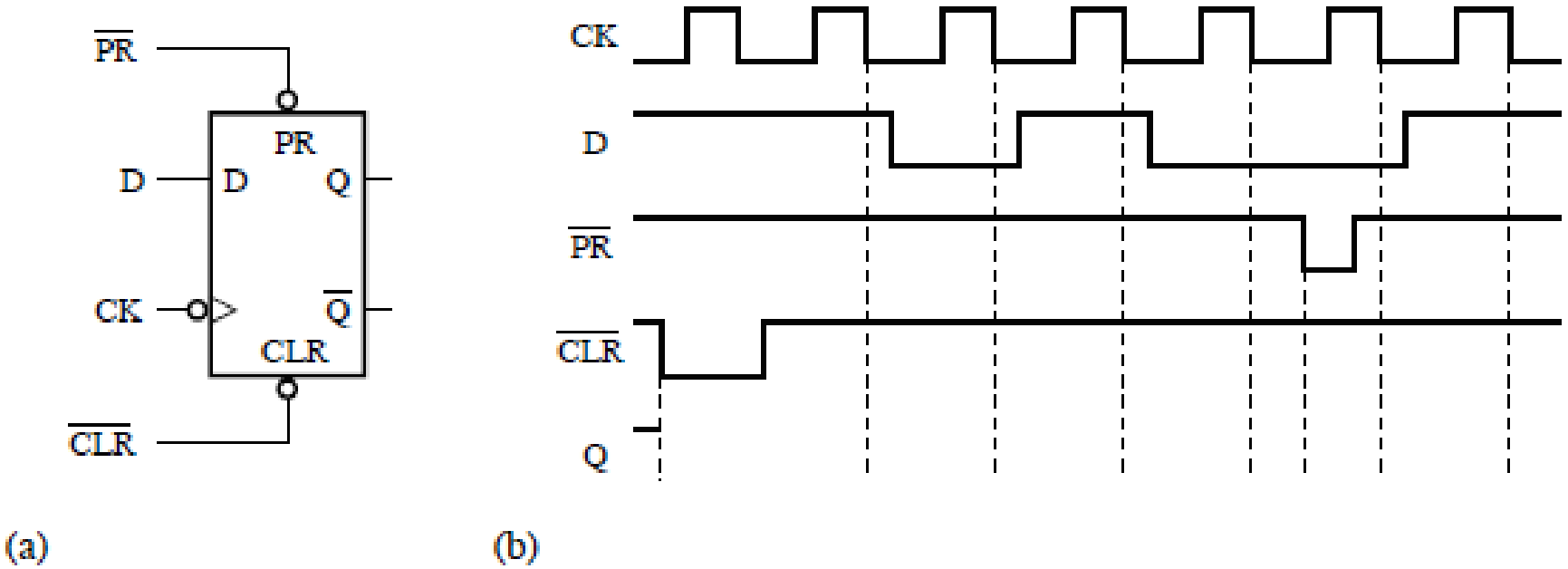
Problem 5-17:
Design a one-input, one-output serial 2's complementer. The circuit accepts a string of bits from the input and generates the 2's complement at the output. The circuit can be reset asynchronously to start and end the operation.



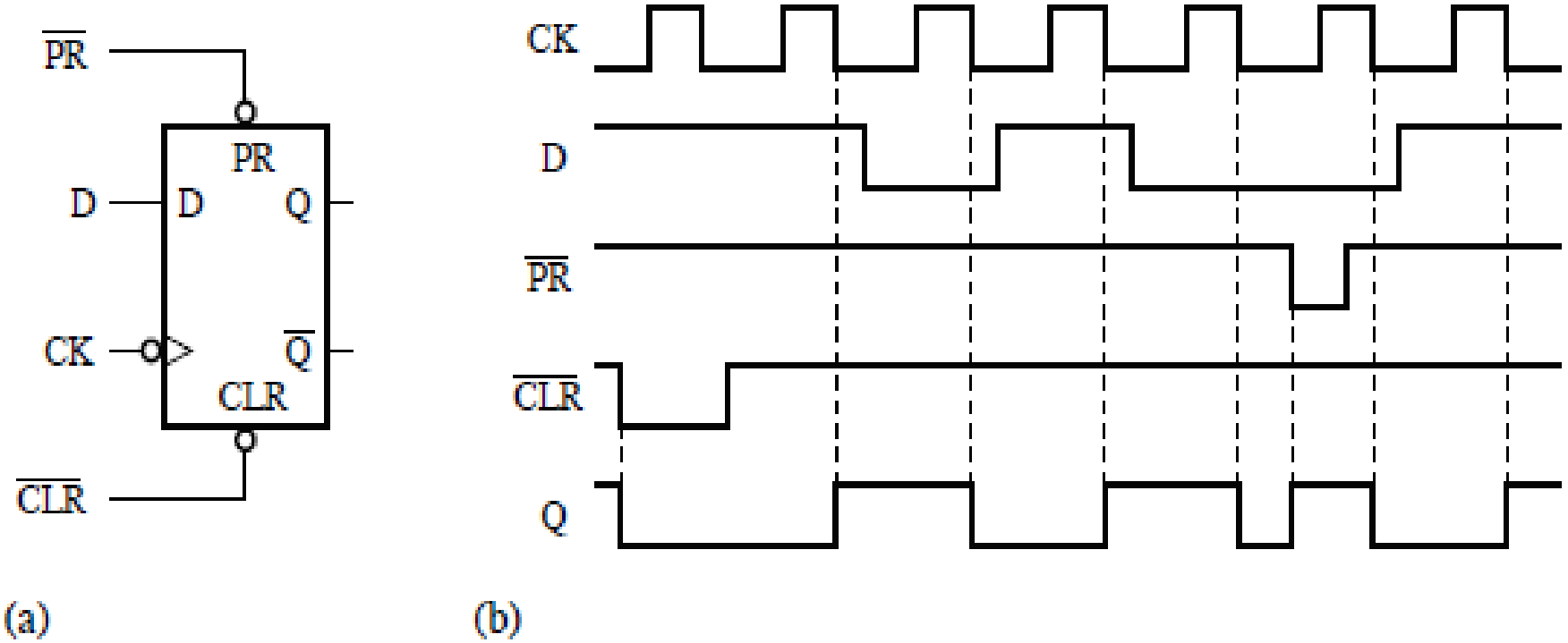
Present state	Input	Next state	Output
A	x	A	y
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	0



Problem: The logic circuit for a D flip-flop with asynchronous inputs is represented in the following Figure (a). Complete the timing diagram in Figure (b).



Solution:



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