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Computer Science Department

CSM51A/EEM16 Midterm Exam #2

Winter Quarter 2015

February 23rd 2015

This is a closed book exam. Absolutely nothing is permitted except pen, pencil and eraser to write your solutions. Any academic dishonesty will be prosecuted to the full extent permissible by university regulations.

Time allowed 100 minutes.

Problem (possible points)	Points
1 (20)	19
2 (20)	20
3 (20)	20
4 (20)	2
5 (20)	12
Total (100)	73

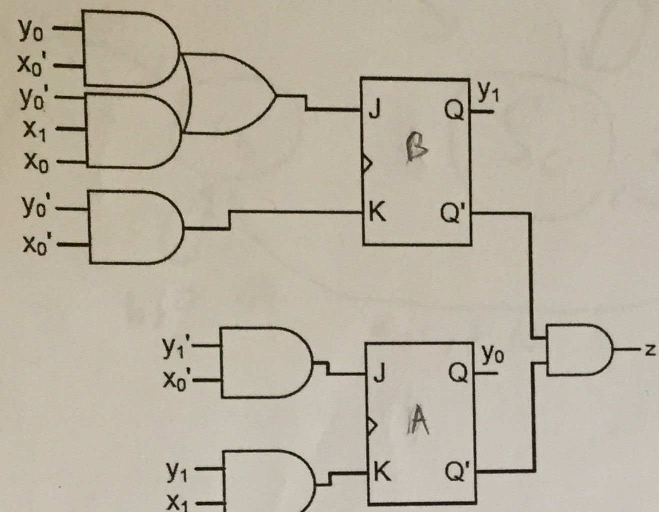
59

14

19 $Q(t+1) = Q(t)K'(t) + Q'(t)J(t)$

Problem 1 (20 points)

Obtain a high-level description (state transition table) of the network shown in the figure below. The system has two input bits x_1 and x_0, with a single output bit z.



PS	J(t)K(t) 00	01	10	11
0	0	0	1	1
1	1	0	1	0

$J_B = y_0x_0' + y_0'x_1x_0$ $K_B = y_0'x_0'$

$Q_B(t+1) = Q_B(y_0'x_0')' + Q_B'(y_0x_0' + y_0'x_1x_0)$

$= y_1(y_0'x_0')' + y_1'(y_0x_0' + y_0'x_1x_0)$

$J_A = y_1'x_0'$ $K_A = y_1x_1$

$Q_A(t+1) = Q_A(y_1x_1)' + Q_A'(y_1'x_0')$

$= y_0(y_1x_1)' + y_0'(y_1'x_0')$

$z = y_1'y_0'$

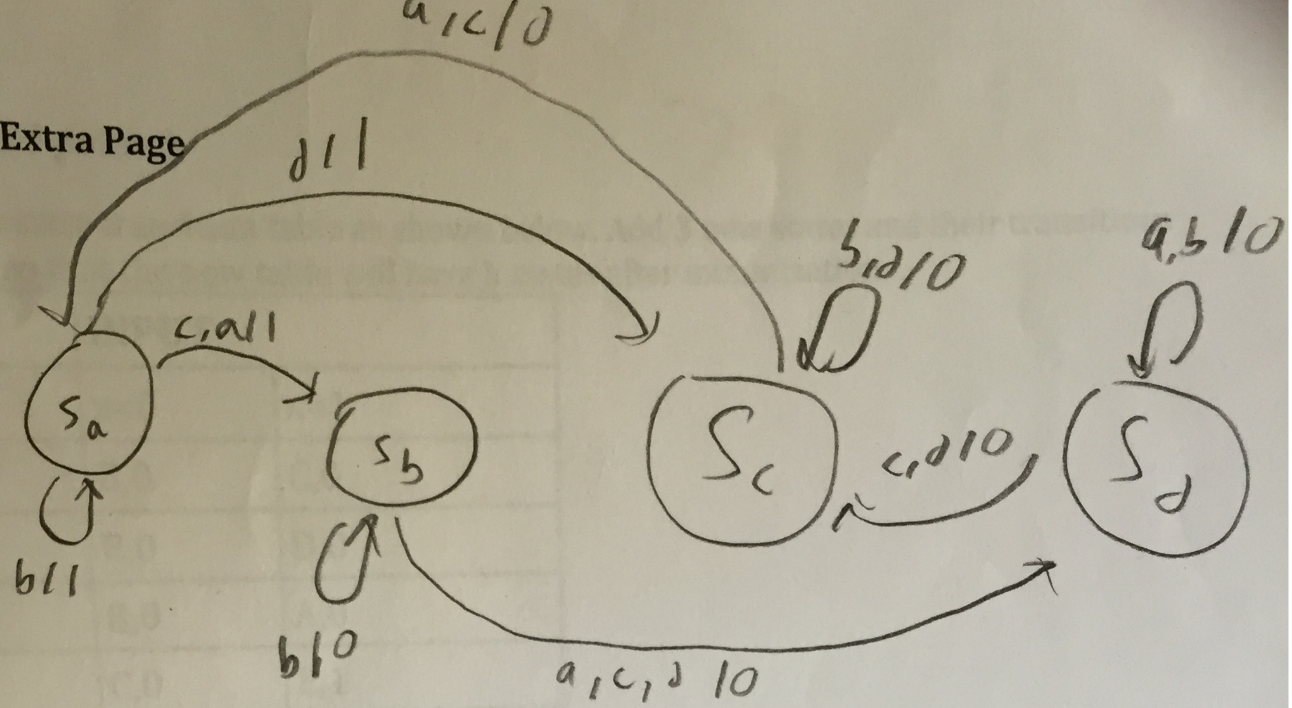
PS y_By_A	NS, z x_1x_0 x=00	x=01	x=10	x=11		z
00	01	00	01	10		1
01	11	01	11	11		0
10	00	10	00	10		0
11	11	11	10	10		0

PS	
a	00
b	01
c	10
d	11

PS	NS, z x=a	x=b	x=c	x=d
S_a	S_b	S_a	S_b	S_c
S_b	S_d	S_b	S_d	S_d
S_c	S_a	S_c	S_a	S_c
S_d	S_d	S_d	S_c	S_c

next page

Problem 1) Extra Page



Problem 2 (20 points)

20

Consider the state transition table as shown below. Add 3 new states and their transitions to the table, so that the new table will have 5 states after minimization.

	INPUT	
PS	x=0	x=1
A	B,0	C,0
B	B,0	D,0
C	B,0	A,0
D	C,0	E,1
E	E,1	F,1
F	F,1	E,1
G	G,1	H,0
H	G,1	I,0
I	G,1	G,0

P1: A B C | D E F | G H I

A	B	C	D	E	F	G	H	I
1	1	1	1	2	2	3	3	3
1	2	1	2	2	2	3	3	3

P2: A C | B | D | E F | G H I

A	C	B	D	E	F	G	H	I
2	2			4	4	5	5	5
1	1			4	4	5	5	5

PS	INPUT x=0	x=1
A	B,0	A,0
B	B,0	D,0
D	A,0	E,1
E	E,1	E,1
~~G~~	~~G,1~~	H,0
H	G,1	I,0
I	G,1	G,0

3 new states

I will add G, H, I

next page

Problem 2) Extra Page

~~original table with~~ 3 new states

G	G, 1	H, 0
H	G, 1	I, 0
I	G, 1	G, 0

fully minimized table after adding 3 states

PS	Input x=0	x=1
A	B, 0	A, 0
B	B, 0	D, 0
D	A, 0	E, 1
E	E, 1	E, 1
G	G, 1	G, 0

20

Problem 3 (20 points)

Using RD flip-flops as defined below, design a system as described below. Use only multiplexers to implement your combinational logic.

Input set: {a, b, c}

Output: 1, if x(t-n, t) = a[b|c]*d+a

0, otherwise

abbcebc

acd

Note: * denotes a character can appear 0 to infinite number of times.

+ denotes a character can appear 1 to infinite number of times.

b|c denotes b or c.

For example, given abcbdda, the output should be 1.

abcbcddabd

	RD			
PS,Q(t)	00	01	10	11
0	1	0	0	1
1	1	0	1	0
	NS, Q(t+1)			

PS	NS, z x=a	x=b	x=c	x=d
S_i	S_a, 0	S_i, 0	S_i, 0	S_i, 0
S_a	S_a, 0	$S_{a[b\|c]^*}$, 0	$S_{a[b\|c]^*}$, 0	$S_{a[b\|c]^*d^+}$, 0
$S_{a[b\|c]^*}$	S_a, 0	$S_{a[b\|c]^*}$, 0	$S_{a[b\|c]^*}$, 0	$S_{a[b\|c]^*d^+}$, 0
$S_{a[b\|c]^*d^+}$	$S_{a[b\|c]^*d^+a}$, 1	S_i, 0	S_i, 0	$S_{a[b\|c]^*d^+}$, 0
$S_{a[b\|c]^*d^+a}$	S_a, 0	$S_{a[b\|c]^*}$, 0	$S_{a[b\|c]^*}$, 0	$S_{a[b\|c]^*d^+}$, 0

minimization

PS i a a[b|c]* a[b|c]*d+a | a[b|c]*d+

2 2 2 2

Problem 3) Extra Page

1			2		3
i	a	a[b|c]*	a[b|c]*d+a		a[b|c]*d+
2	2	2	2		
2	2	2	2		
1	2	2	2		
1	3	3	2		
1			3		

minimized

PS		a x=00	b x=01	c x=10	d x=11
S_i	00	01,0	00,0	00,0	00,0
$S_{a[b\|c]*}$	01	01,0	01,0	01,0	10,0
$S_{a[b\|c]*d+}$	10	01,1	00,0	00,0	10,0

$Q_1 Q_0$

excitation table

Q(t) → Q(t+1)	RD
0 → 0	01 / 10
0 → 1	00 / 11
1 → 0	-1
1 → 1	-0

R_1

Q_1Q_0 \ x_1x_0	00	01	10	11
00	1	1	1	1
01	1	1	1	1
11	-	-	-	-
10	-	-	-	-

$R_1 = Q_1'$

D_1

Q_1Q_0 \ x_1x_0	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	-	-	-	-
10	1	1	0	1

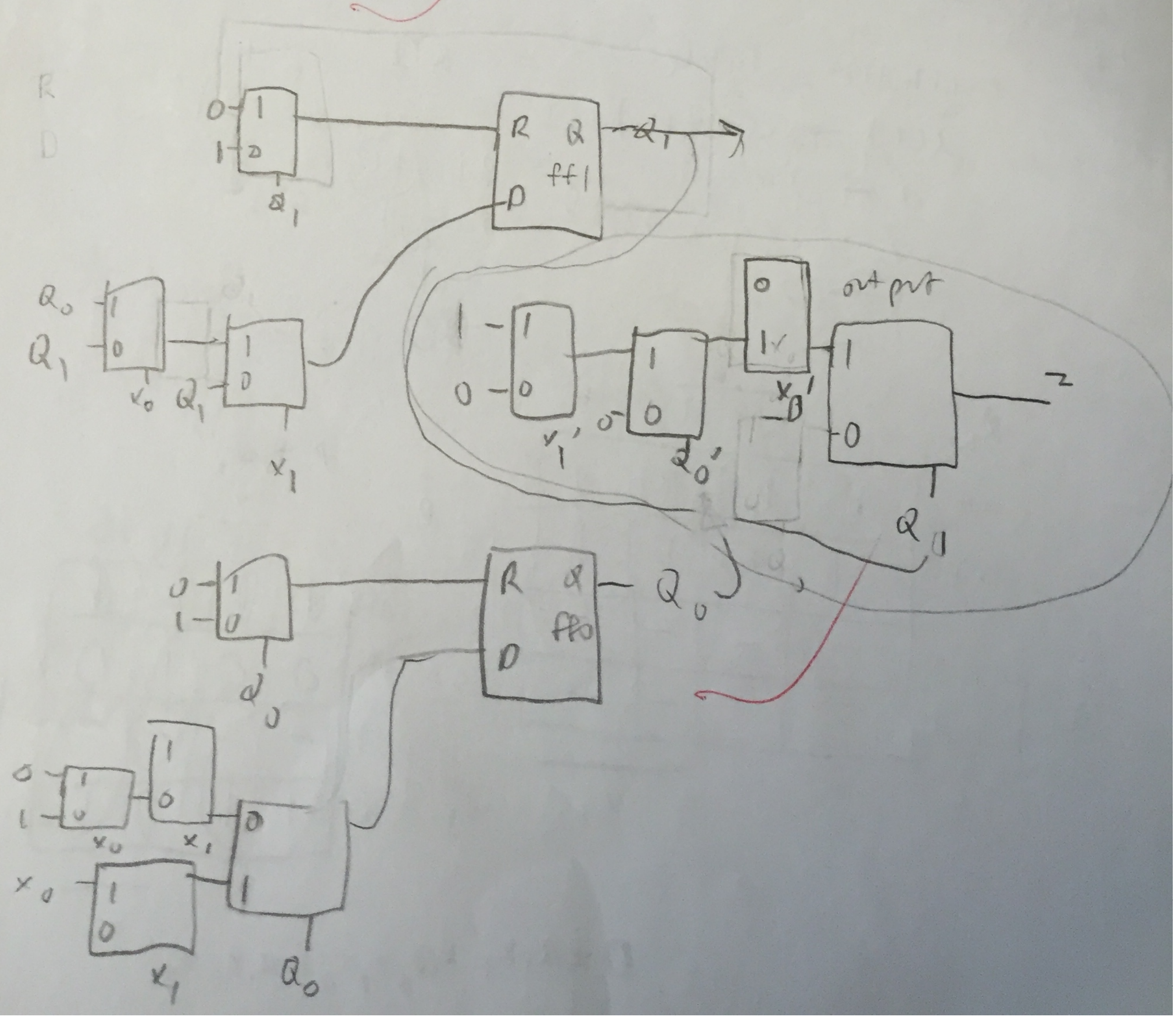
$$D = Q_1 x_1' + Q_0 x_1 x_0 + Q_1 x_1 x_0'$$

R_0	00	01	11	10
00	1	1	1	1
01	–	–	–	–
11	–	–	–	–
10	1	1	1	1

$R_0 = Q_0'$

D_0	00	01	11	10
00	1	0	0	0
01	0	0	1	0
11	–	–	–	–
10	1	0	0	0

$D_0 = Q_0 x_1 x_0 + Q_0' x_1' x_0'$



1001001

100110

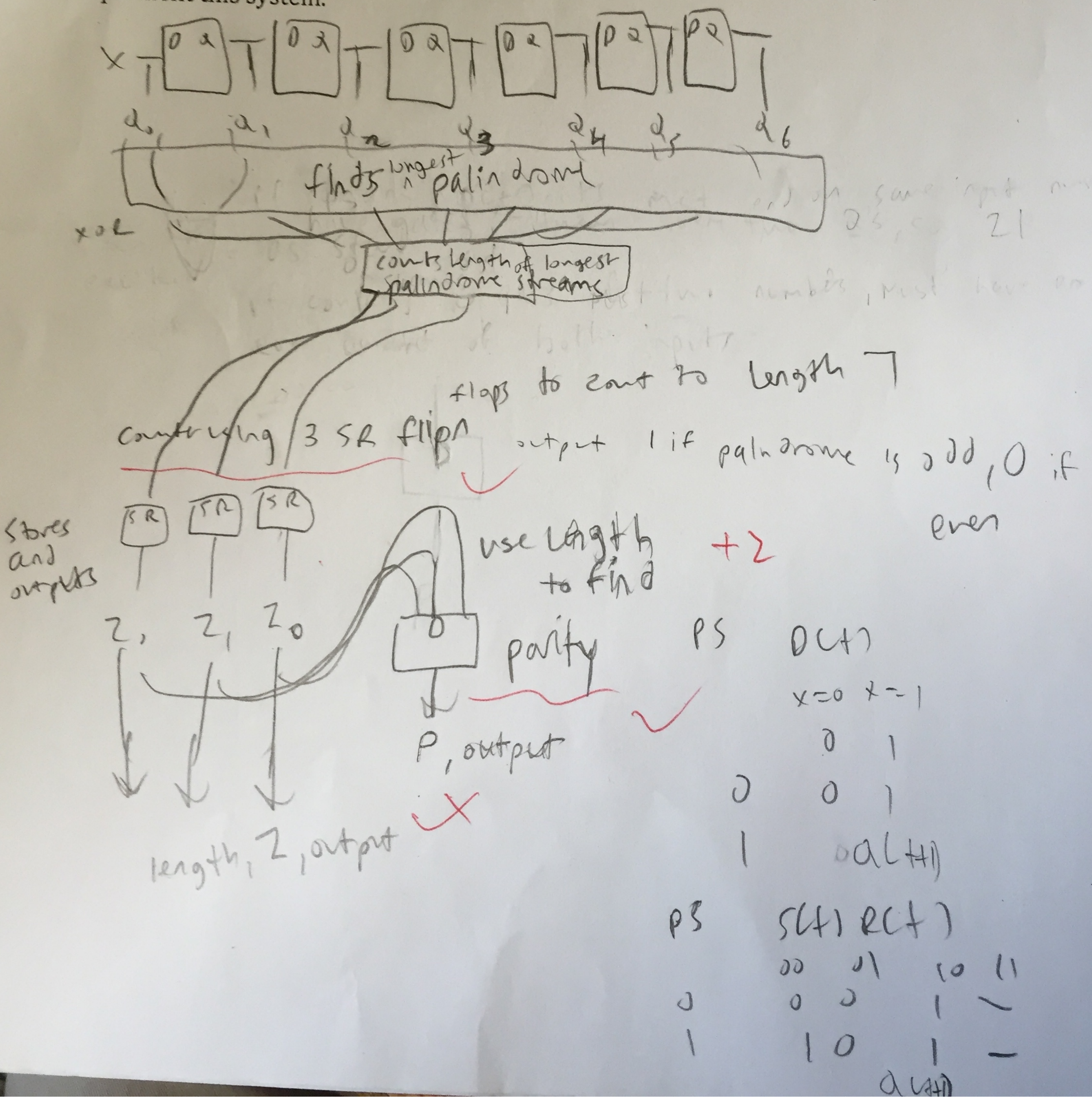
1001

Problem 4 (20 points) 2

Given an input stream of 0s and 1s, design a system that outputs the length, **Z**, of the largest palindrome found in the last 7 inputs, along with the parity, **P**, of the length of that palindrome. A palindrome is a string that is spelled the same forwards as it is backwards. For example, the following strings are palindromes: 10101, 11, 1001, 0000. **P** is equal to 1 when the length of the palindrome is odd, and 0 when its length is even. Your system should only consider palindromes of length 2 to 7.

For example, given the following input stream, 1010101, the output should be Z=7 and P=1. For the input stream, 1010000, the output should be Z=4 and P=0.

Use any type, any number of flip-flops and combinational gates of your choosing to implement this system.



Problem 5 (20 points)

12

Using at most 1 JK flip-flop, at most 1 SR flip-flop, and at most 8 D flip-flops, design a system as specified below. You may use any gates to implement your combinational logic.

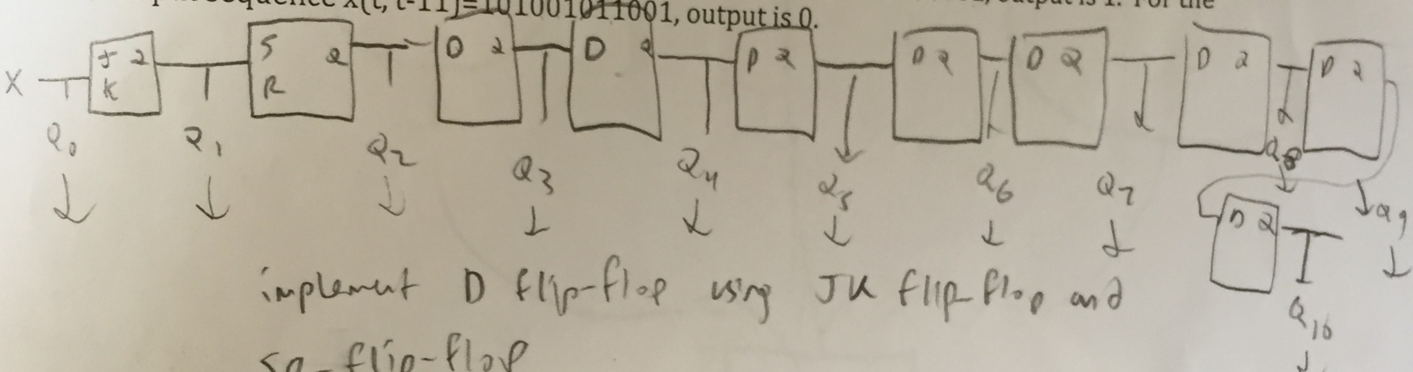
Input set: {0,1}

1-10 0-0-

Output: 1, if x(t, t-3)=11-0, x(t-4, t-7)=1-10 or 0-0-, x(t-8, t-11)=1001

0, otherwise

For example, for the given input sequence x(t, t-11)=110010101001, output is 1. For the input sequence x(t, t-11)=101001011001, output is 0.



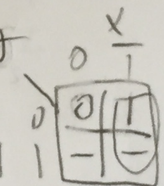
implement D flip-flop using JK flip-flop and SR-flip-flop

Q(t) → Q(t+1)	D
0 → 0	0
0 → 1	1
1 → 0	0
1 → 0	1

11 D-FFs needed

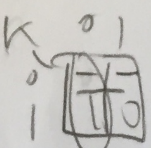
-8K

PS	NS	J(t) K(t)			
		00	01	10	11
0	0	0		1	1
1	1	0		1	0

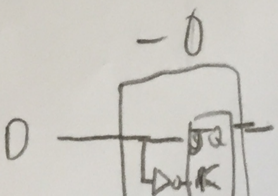


J = x

Q(t) → Q(t+1)	JK
0 → 0	0-
0 → 1	1-
1 → 0	-1
1 → 1	-0

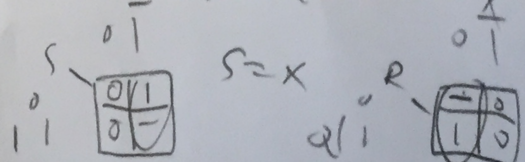


K = x'



PS	NS	S(t) R(t)			
		00	01	10	11
0	0	0		1	-
1	1	0		1	-

Q(t) → Q(t+1)	SR
0 → 0	0-
0 → 1	10
1 → 0	01
1 → 1	-0



S = x

R = x'

next page

Problem 5) Extra Page