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First Last

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University of California

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Computer Science Department

CSM51A Midterm Exam #2

Fall Quarter 2011

Nov 9th 2011

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.

The exam has 5 problems.

Time allowed 100 minutes.

Problem (possible points)	Points regrade
1 (20)	20
2 (20)	17 → 20
3 (20)	20
4 (20)	6 → 14
5 (20)	15
Total (100)	78 → 89

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Problem 1 (20 points)

Using only GH flip-flops (state transition shown below) and multiplexers, implement the system given by the high-level table.

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

PS, Q(t)	X = 0	X = 1
A	F, 0	E, 0
B	G, 0	B, 1
C	B, 0	H, 0
D	F, 0	H, 0
E	G, 0	C, 0
F	G, 0	F, 1
G	E, 0	A, 1
H	G, 0	A, 0
	NS Q(t+1), Z	

$P_1 = \{A,C,D,E,H\}\{B,F,G\}$ (2 2 2 2 2 2 2 1 / 1 1 1 1 1 2 2 1)

$P_2 = \{A,C,D,E,H\}\{B,F\}\{G\}$ (2 2 2 3 3 3 3 / 1 1 1 1 1 2 2)

$P_3 = P_4 = \{A,C,D\}\{E,H\}\{B,F\}\{G\}$ ✓

PS →	NS	GH
0	0	10
0	1	0-
1	0	1-
1	1	01

✓

G_1

1	0	0	0
0	1	1	1

H_1

0	-	1	1
-	0	-	-

G_0

0	1	1	0
0	0	1	1

H_0

-	0	-	1
-	-	-	-

Z

0	0	0	0
0	1	0	1

✓

	PS	X=0	X=1
00	A	B, 0	E, 0
01	B	G, 0	B, 1
11	E	G, 0	A, 0
10	G	E, 0	A, 1

✓

q_1q_0 PS	X=0	X=1
00	01, 0	11, 0
01	10, 0	01, 1
11	10, 0	00, 0
10	11, 0 2	00, 1

$G_1 = Xq_0 + Xq_1 + X'q_1'q_0'$

$H_1 = q_1$

$G_0 = Xq_1 + X'q_0$

$H_0 = q_1$

$Z = Xq_1'q_0 + Xq_1q_0'$

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Problem 1) Extra Page

G_1

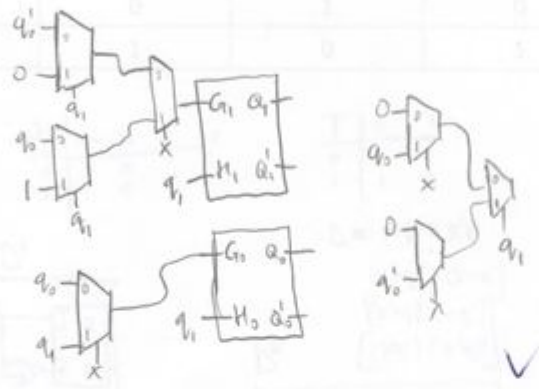
X	$G_{1X'} = q_1'q_0'$
	$G_{1X} = q_0 + q_1$

G_0

X	$G_{0X'} = q_0$
	$G_{0X} = q_1$

Z

P_{V_1}	$Zq_1' = Xq_0$
	$Zq_1 = Xq_0'$



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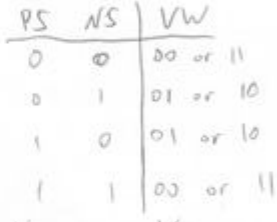
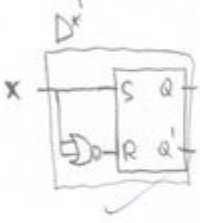
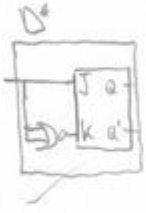
Problem 2 (20 points)

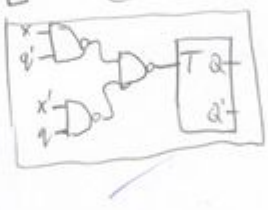
Design a system that accepts as input a single input stream and outputs 1 if x(t-4, t) is 100-0. You have at your disposal 1 SR flip-flop, 1 JK flip-flop, 1 T flip-flop, 1 VW flip-flop (state transition table below), and as many NAND gates and NOR gates as you need.

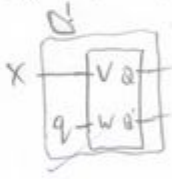
	NS			
PS	VW = 00	VW = 01	VW = 11	VW = 10
0	0	1	0	1
1	1	0	1	0

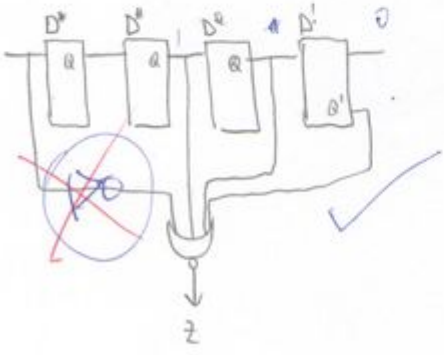












(17) → 20

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Problem 2) Extra Page

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Problem 3 (20 points)

a) (10 points) Design a system that accepts as input an input stream with possible input set **{a, b, c}** and outputs 1 if x(t-3, t) is **abbc**.

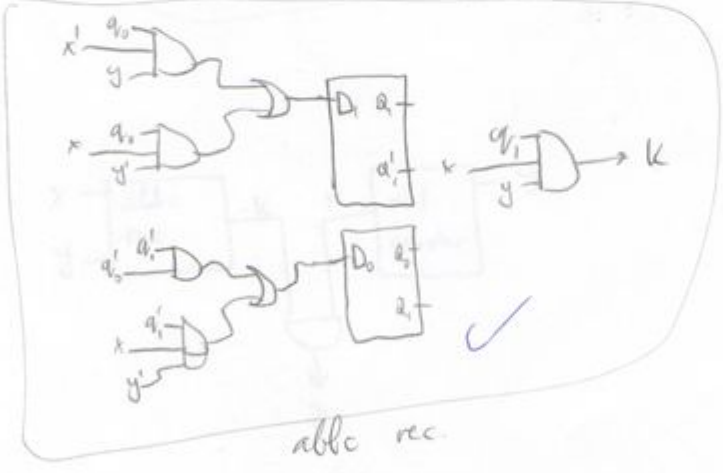
b) (10 points) Design a system that accepts as input an input stream with possible input set **{a, b, c}** and outputs 1 if x(t-3, t) is **abbc** and there have been an odd number of **b**'s. Hint: you may re-use any modules you designed in part **a)**.

a)

PS	x=a	x=b	x=c
00 Si	Sa,0	Si,0	Si,0
01 Sa	Sa,0	Sab,0	Si,0
10 Sab	Sa,0	Sabb,0	Si,0
11 Sabb	Sa,0	Si,0	Si,1

q_1q_0 PS	xy 00	01	10	11
00	01,0	00,0	00,0	—
01	01,0	10,0	00,0	—
10	01,0	11,0	00,0	—
11	01,0	00,0	00,1	

$D_1 = q_0x'y + q_0xy'$ $D_0 = q_1'q_0' + q_1'xy'$ $z = q_1xy$



abbc rec

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Problem 3) Extra Page

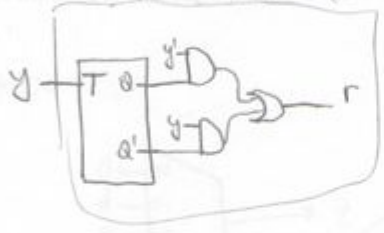
b)

PS	x=a	x=b	x=c
S_e	S_e, 0	S_{odd}, 1	S_o, 0
S_o	S_o, 1	S_e, 0	S_o, 1

PS (q)	xy = 00	01	10	11
0	0,0	1,1	0,0	–
1	1,1	0,0	1,1	–

$T = y$ $\quad z = qy' + q'y$

odd counter (starts even)



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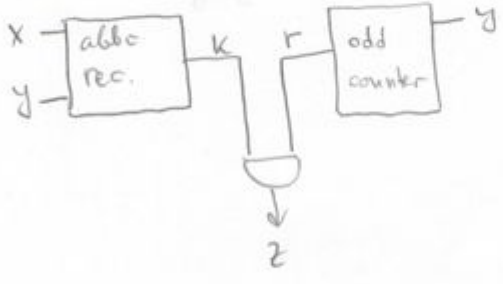

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Problem 4 (20 points)

a) (6 points) Implement the following function using the minimal number of 2-select input (4-data input) MUXes and no other combinational logic.

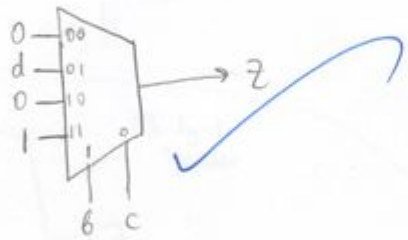
	cd= 00	cd= 01	cd= 11	cd= 10
ab = 00	0	0	1	0
ab = 01	0	0	1	1
ab = 11	0	0	1	1
ab = 10	0	0	1	0

b) (14 points) Design a system that adds two 32-bit numbers using the minimal number of 4-select input (16-data input) MUXes and no other combinational logic.

a)

$z = bc + cd$

bc	
	$z_{b'c'} = 0$
	$z_{b'c} = d$
	$z_{bc'} = 0$
	$z_{bc} = 1$



b

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Problem 4) Extra Page

B)

a	b	c_{in}	z	c_{out}
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

8 ✓

z

a \ c_{in}	0	1	0	1
0	1	0	1	0
1	0	1	0	1

$z = ab'c_{in}' + abc_{in} + a'b'c_{in} + a'bc_{in}'$ ✓

c_{out}

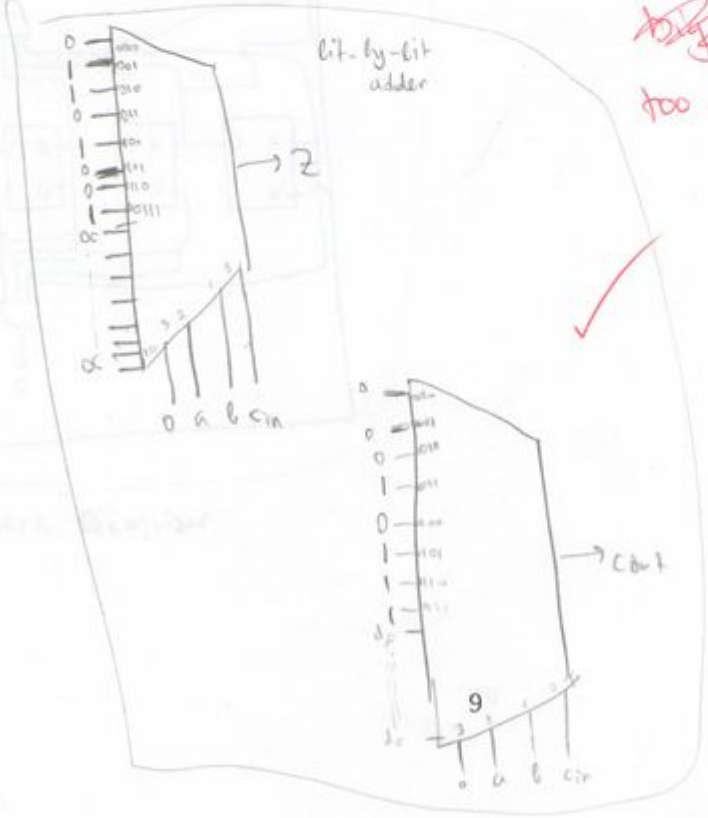
a \ c_{in}	0	1	0	1
0	0	0	1	0
1	0	1	1	1

$c_{out} = ac_{in} + ab + bc_{in}$ ✓

adder chain? -4

~~big MUXes~~

too many MUXes: -2



✓

no final

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Problem 5 (20 points)

Design a system that outputs 1 once it recognizes the following 4 patterns **in order** (otherwise, it outputs 0):

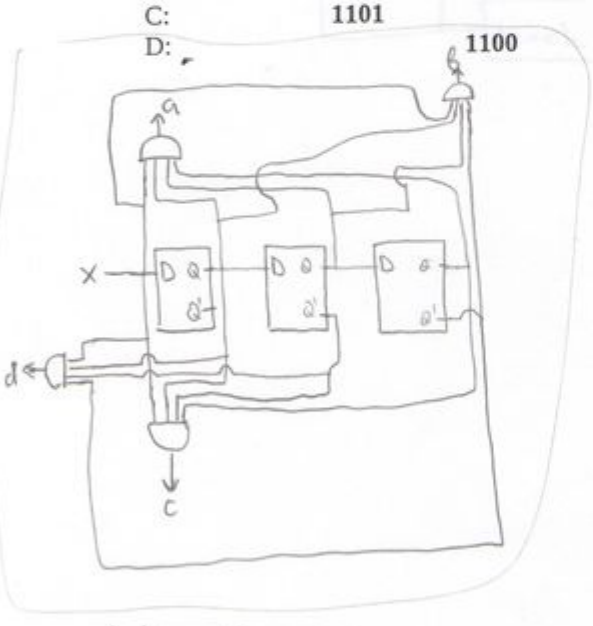
A) 1111
B) 1110
C) 1101
D) 1100

For example, the input sequence:

0111100111011010101**1100**

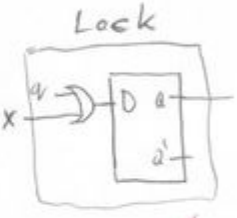
will output 1 because it recognizes pattern A, then B, then C, then finally D. To clarify:

0111100111011010101**1100**
A: **1111**
B: **1110**
C: **1101**
D: **1100**



Pattern Recognizer

PS	X=0	X=1
0	0, 0	1, 1
1	1, 1	1, 1



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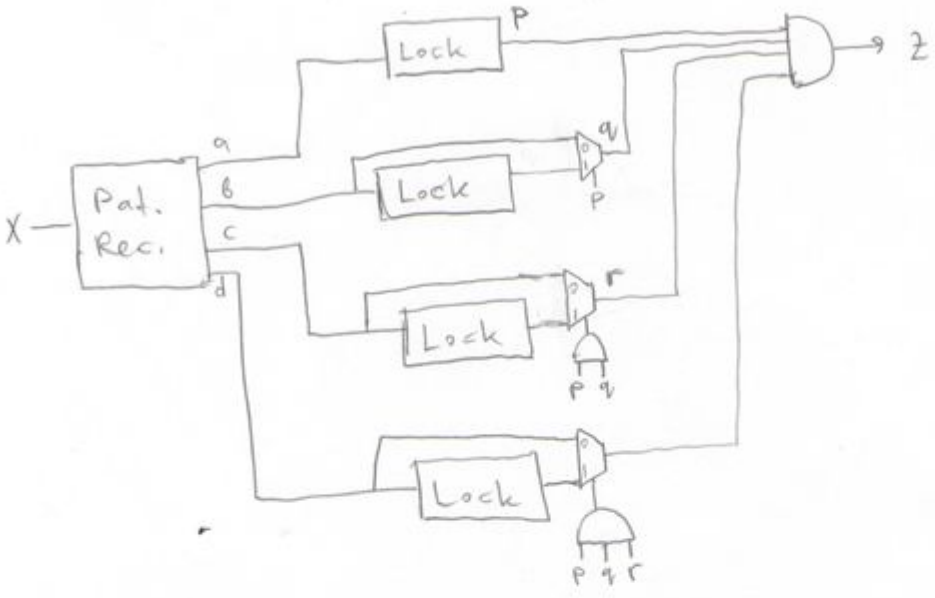
Extra Page



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