CS M51A, Fall 2022, Assignment 3
(Total Mark: 100 points, 10%)

Due: Fri Nov 11, 10:00 AM Pacific Time

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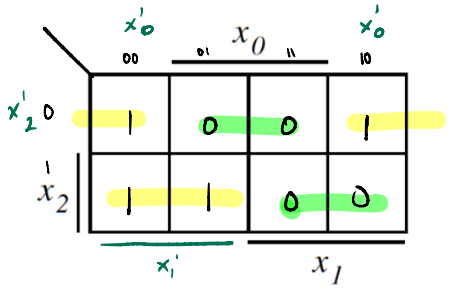
Note: You must complete the assignments entirely on your own, without discussing with others.

1. Given the following table:

A x_2	B x_1	C x_0	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(a) (4 points) Fill out the k-maps for this table.



(b) (4 points) Write the minimal sum of products for F.

$F_{sop} = x_1'x_2 + x_0'x_2'$

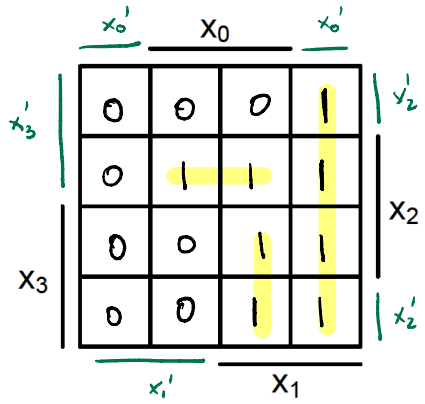
(c) (4 points) Write the minimal product of sums for F.

$F = (x_2' + x_0')'(x_1 + x_2)'$

$F_{pos} = (x_2 + x_0')(x_1' + x_2')$

2. Given $f(x_3, x_2, x_1, x_0) = x_3x_2x_1x_0' + x_3x_2x_1x_0 + x_3'x_2x_1x_0 + x_3'x_2x_1x_0 + x_3'x_2x_1x_0' + x_3'x_2'x_1x_0' + x_3x_2'x_1x_0 + x_3x_2'x_1x_0'$

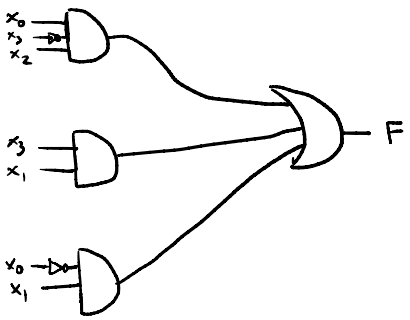
(a) (8 points) Fill out the following K-maps.



(b) (4 points) Write the minimal sum of products expression for f.

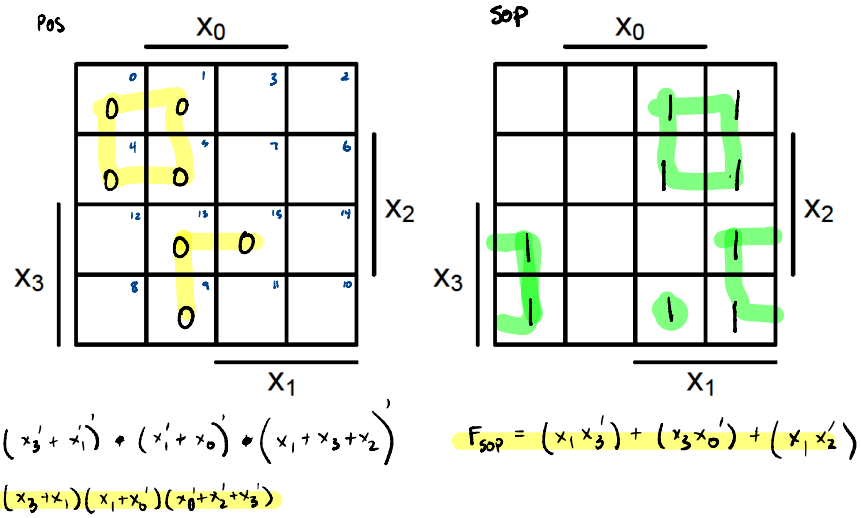
$F = x_0x_3'x_2 + x_3x_1 + x_0'x_1$

(c) (4 points) Draw the gate level design for (b)



3. Using K-maps, find the minimal SOP and POS that are equivalent to the following expressions ($dc(\cdots)$ indicates the "don't care" terms):

   (a) (10 Points) $F(x_3, x_2, x_1, x_0) = \Pi M(0, 1, 4, 5, 9, 13, 15)$

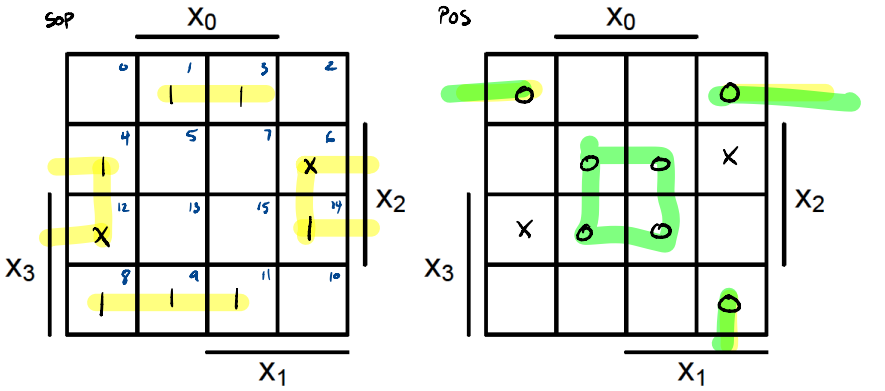


$F_{POS} = (x_3' + x_1')' \cdot (x_1' + x_0)' \cdot (x_1 + x_3 + x_2)'$

$F_{POS} = (x_3 + x_1)(x_1 + x_0')(x_0' + x_2' + x_3')$

$F_{SOP} = (x_1 x_3') + (x_3 x_0') + (x_1 x_2')$

   (b) (10 Points) $F(x_3, x_2, x_1, x_0) = \Sigma m(1, 3, 4, 8, 9, 11, 14)$, $dc(x_3, x_2, x_1, x_0) = \{m(6), m(12)\}$



$F_{SOP} = x_0 x_2' + x_2 x_0' + x_3 x_2' x_1'$

$F_{POS} = (x_2 \quad x_0)' + (x_3' \; x_2' \; x_0')' + (x_2' \; x_1 \; x_0')'$

$F_{POS} = (x_2' + x_0') + (x_3 + x_2 + x_0) + (x_2 + x_1' + x_0)$

4. (6 Points) Determine whether the sequential systems described by the following tables corresponds to Moore or Mealy machines.

	Input	
PS	$x=0$	$x=1$
A	$C,1$	$B,1$
B	$A,1$	$C,0$
C	$A,1$	$B,1$
	NS, Output	

Input ≠ Output

Mealy

	Input	
PS	$x=0$	$x=1$
A	$B,0$	$A,0$
B	$B,1$	$C,1$
C	$A,1$	$B,1$
	NS, Output	

Input = output

Moore

	Input	
PS	$x=0$	$x=1$
A	$A,0$	$B,0$
B	$A,1$	$C,1$
C	$A,1$	$D,0$
D	$A,0$	$A,0$
	NS, Output	

Input ≠ output

Mealy

Input ≠ Output ⇒ output depends on state and input ⇒ Mealy

Input = output ⇒ output depends on only state ⇒ moore

5. Consider the following state table:

	Input			
PS	$x=a$	$x=b$	$x=c$	$x=d$
A	$G,1$	$E,0$	$G,1$	$C,0$
B	$D,0$	$G,0$	$E,0$	$F,1$
C	$E,1$	$G,0$	$F,1$	$A,0$
D	$E,1$	$G,0$	$F,1$	$C,0$
E	$C,0$	$G,0$	$E,0$	$F,1$
F	$C,1$	$B,1$	$A,0$	$B,1$
G	$C,0$	$E,0$	$G,0$	$F,1$
H	$G,1$	$E,0$	$F,1$	$A,0$
	NS,z			

(a) (8 Points) Answer True or False for the questions:

- State C and D are 2-equivalent. T
- State A and H are 1-distinguishable. F
- State B and F are 1-equivalent. F
- State E and G are 1-distinguishable. F

(b) (8 Points) Simplify this table by reducing the state set as much as possible

P_1	A C D H	B E G	F
a	2 2 2 2	1 1 1	
b	2 2 2 2	2 2 2	
c	2 3 3 3	2 2 2	
d	1 1 1 1	3 3 3	

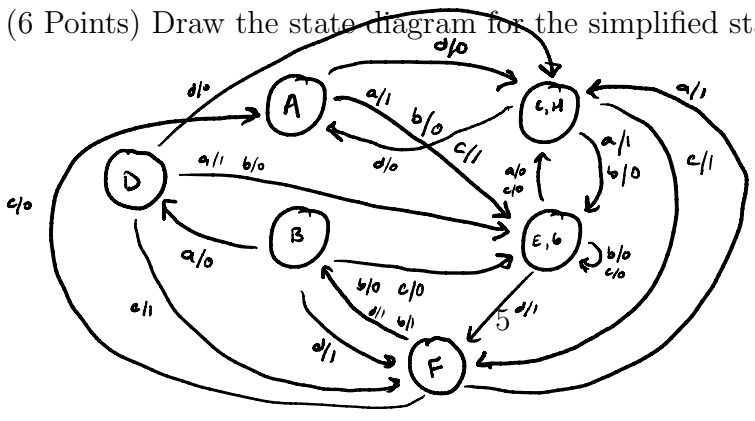
P_2	A	C D H	B E G	F
a		3 3 3	2 2 2	
b		3 3 3	3 3 3	
c		4 3 4	3 3 3	
d		1 4 1	4 4 4	

P_3	A	D	C H	B E G	F
a			4 4	2 3 3	
b			4 4	4 4 4	
c			5 5	4 4 4	
d			1 1	5 5 5	

(A) (D) (C,H) (E,G) (B) (F)

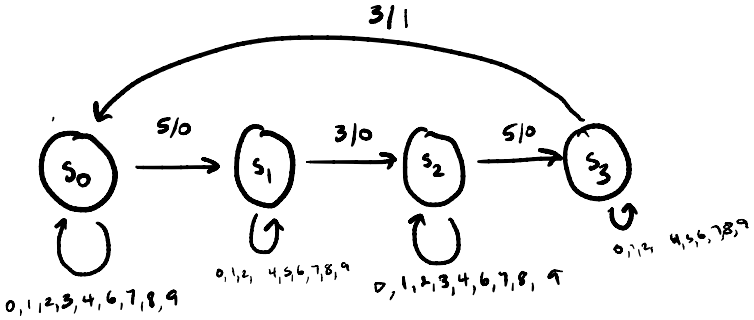
P_4	A	D	C H	E G	B	F
			4 4	3 3		
			4 4	4 4		
			6 6	4 4		
			1 1	6 6		

(c) (6 Points) Draw the state diagram for the simplified state table.



6. (6 Points) Consider a sequential system that has a input $x(t) \in \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ and one bit as output $y(t) \in \{0, 1\}$. The output is one if the number of times the pattern 53 has occurred in x(0, t) is even. Otherwise, the output is zero. Show the state diagram of the system.

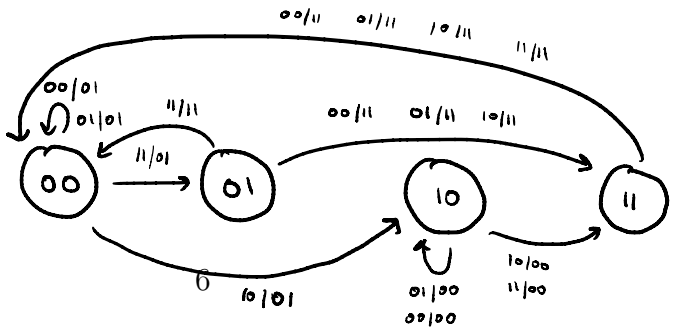
if ε represents the end of input



7. (10 Points) Consider the following next-state table and corresponding output table below. The inputs are C and D; the outputs are R and M. NS presents the next state, and $S = (S_1, S_0)$ presents current state. Draw the state diagram of the system using binary coding specification. Note that the X's are don't cares.

	S_1	S_0	C	D	NS_1	NS_0	R	M
00	0	0	0	X	0	0	0	1
	0	0	1	0	1	0	0	1
	0	0	1	1	0	1	0	1
01	0	1	0	0	1	1	1	1
	0	1	0	1	1	1	1	1
	0	1	X	0	1	1	1	1
	0	1	1	1	0	0	1	1
10	1	0	0	X	1	0	0	0
	1	0	1	X	1	1	0	0
11	1	1	X	X	0	0	1	1

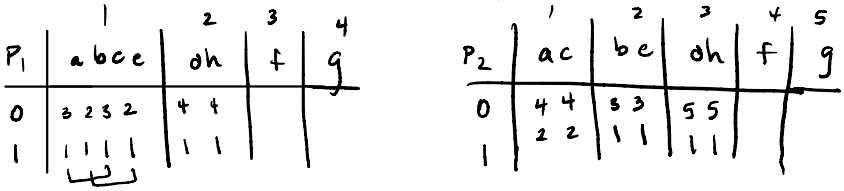
S_1	S_0	R	M
0	0	0	1
0	1	1	1
1	0	0	0
1	1	1	1



8. Simplify the following state tables by reducing the state set as much as possible.

(a) (4 Points)

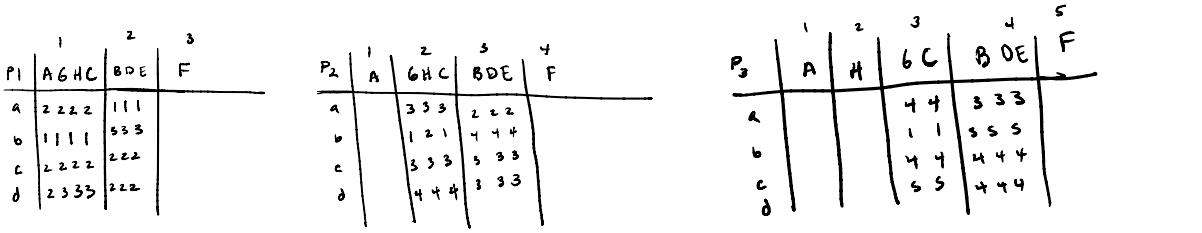
	Input	
PS	$x = 0$	$x = 1$
a	$f, 0$	$b, 0$
b	$d, 0$	$c, 0$
c	$f, 0$	$e, 0$
d	$g, 1$	$a, 0$
e	$d, 0$	$c, 0$
f	$f, 1$	$b, 1$
g	$g, 0$	$h, 1$
h	$g, 1$	$a, 0$
	NS,z	



$P = (a, c)\ (b, e)\ (d, h)\ (f)\ (g)$

(b) (4 Points)

	Input			
PS	$x = a$	$x = b$	$x = c$	$x = d$
A	$E, 1$	$C, 0$	$B, 1$	$E, 1$
B	$C, 0$	$F, 1$	$E, 1$	$B, 0$
C	$B, 1$	$A, 0$	$D, 1$	$F, 1$
D	$G, 0$	$F, 1$	$E, 1$	$B, 0$
E	$C, 0$	$F, 1$	$D, 1$	$E, 0$
F	$C, 1$	$F, 1$	$D, 0$	$H, 0$
G	$D, 1$	$A, 0$	$B, 1$	$F, 1$
H	$B, 1$	$C, 0$	$E, 1$	$F, 1$
	NS,z			



$P = (A) + (H) + (G, C) + (B, D, E) + F$