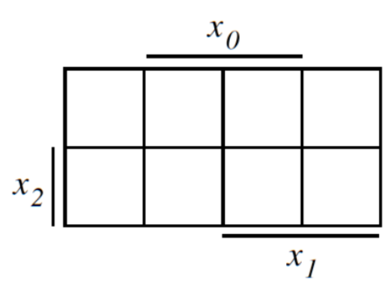
CS M51A, Winter 2021, Assignment 5
(Total Mark: 110 points, 11%)

Due: Wed Feb 10th, 10:00 AM Pacific Time
Student Name:
Student ID:
Note: You must complete the assignments entirely on your own, without discussing with others.

1. Given the following table:

x_2	x_1	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.

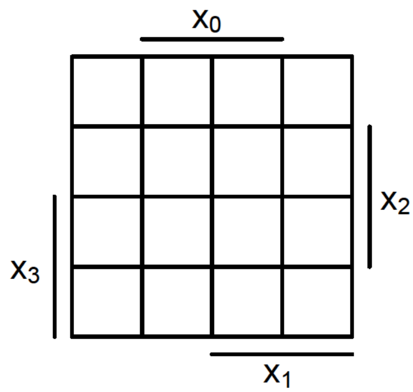


(b) (4 points) Write the minimal sum of products for F.

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

2. Given $f(x_3, x_2, x_1, x_0) = x_3x_2x_1x_0' + x_3x_2x_1x_0 + x_3'x_2x_1'x_0 + x_3'x_2x_1x_0 + x_3x_2x_1'x_0' + x_3x_2x_1x_0' + x_3x_2'x_1x_0 + x_3x_2'x_1x_0'$

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



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

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

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

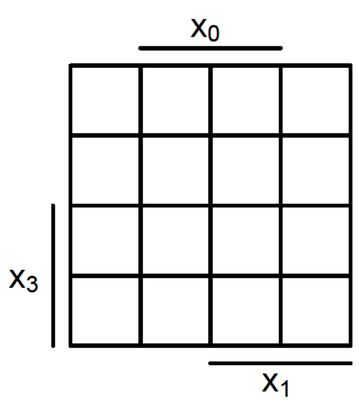
(e) (4 points) Draw the gate level design for (c)

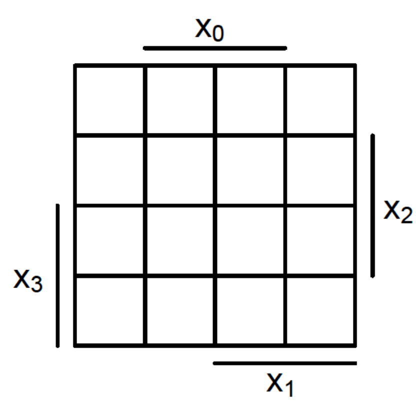
3. Consider a system that takes a decimal number (i.e. 0 to 9) as an input. The input is presented using a 4-bit unsigned binary code (x_3, x_2, x_1, x_0). For example, if the input is 7, $x_3 = 0, x_2 = 1, x_1 = 1, x_0 = 1$. The system has a 2-bit output (z_1, z_0). z_1 is one when the input is an odd number, otherwise it is zero. z_0 is one when the input is larger or equal to 5, otherwise it is zero.

(a) (8 points) Fill the truth table for this system.

x_1	x_2	x_1	x_0	z_1	z_0
0	0	0	0		
0	0	0	1		
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1		
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1		
1	1	1	0		
1	1	1	1		

(b) (4 points) Fill out the k-maps for this system (Left: z_1, Right: z_0).





(c) (4 points) Write the minimal sum of products expression for the outputs (for both z_1 and z_0).

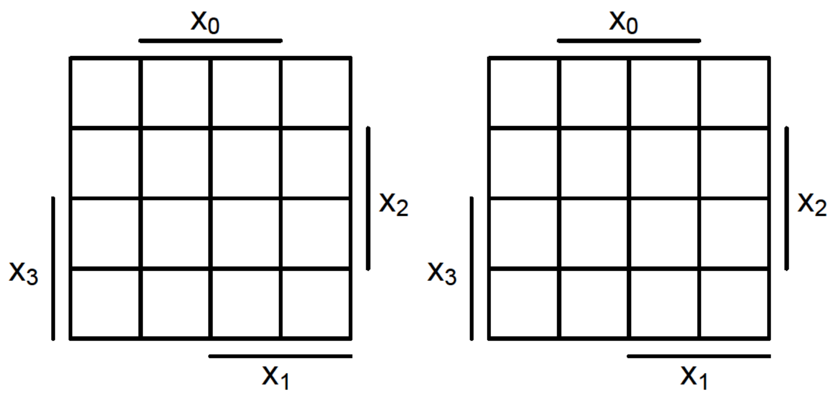
(d) (4 points) Write the minimal product of sums expression for the outputs (for both z_1 and z_0).

(e) (4 points) Draw a gate level design for (b) (for both z_1 and z_0)

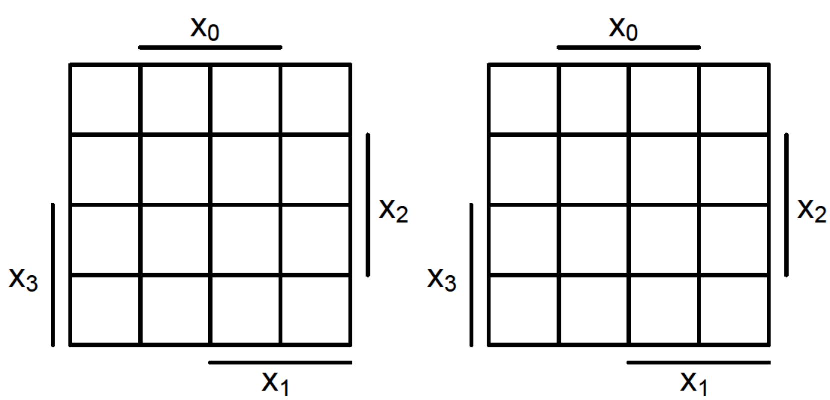
(f) (4 points) Draw a gate level design for (c) (for both z_1 and z_0)

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

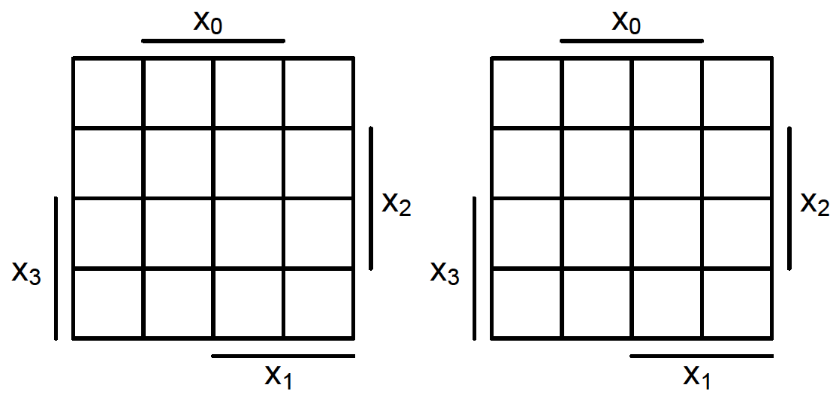
(a) (5 Points) $F(x_3, x_2, x_1, x_0) = \Pi M(1, 3, 4, 7, 10, 13, 14, 15)$



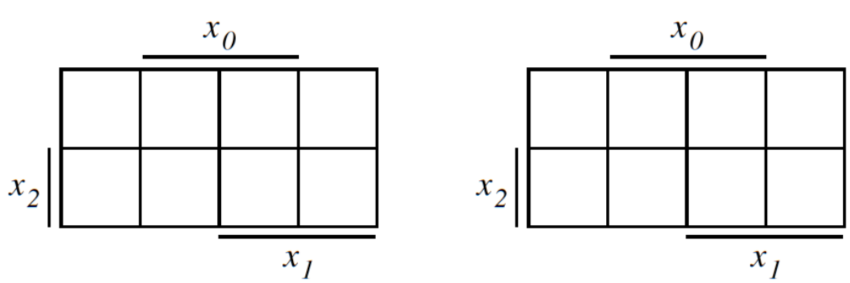
(b) (5 Points) $F(x_3, x_2, x_1, x_0) = \Sigma m(0, 4, 5, 9, 11, 14, 15)$, $dc(x_3, x_2, x_1, x_0) = \{m(2), m(8)\}$



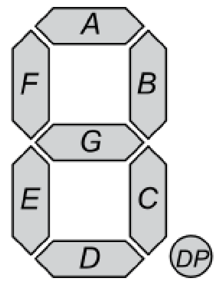
(c) (5 Points) $F(x_3, x_2, x_1, x_0) = \Sigma m(0, 1, 2, 5, 8, 9, 10)$



(d) (5 Points) $F(x_2, x_1, x_0) = \Sigma m(0, 1, 4, 6)$

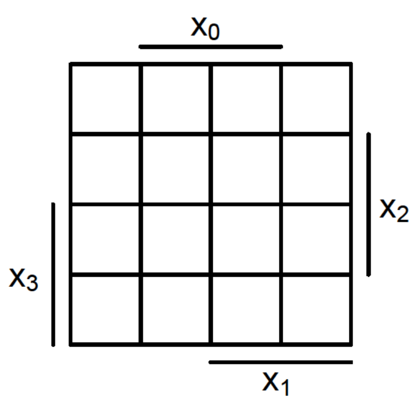


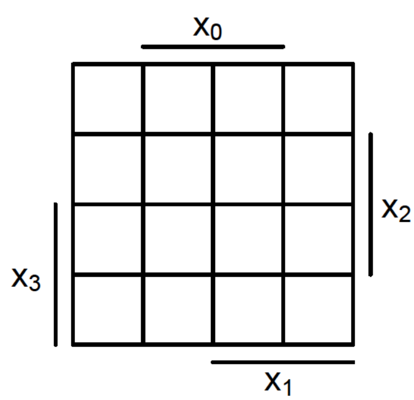
5. Given the following (uncompleted) high-level specification:
Input: $x \in \{0, 1, 2, \cdots, 9\}$, represented in unsigned binary code by 4 bits, $x = (x_3, x_2, x_1, x_0)$;
Output: $z \in \{0, 1\}$. z is one bit and indicates whether the "G" segment of the 7-segment display below is illuminated when the displayed number is x. **For example**: the "G" segment is illuminated when $x = 8$, while it will be off when $x = 0$.



(a) (8 Points) Write the sum of minterms and product of maxterms of z given $\{x_3, x_2, x_1, x_0\}$.

(b) (8 Points) Simplify the sum of minterms and product of maxterms in (a) using K-Map. (Hint: you may need to identify and utilize the "don't care" terms in this system)





(c) (8 points) Draw a gate level design for the minimal SOP and POS in (b)

6. (2 Points) What is an advantage of a NAND-NAND network over a AND-OR network?