CSC 137 Cokgor - K-Map Exercises

(Answers are at the back)

1) Simplify the following Boolean equation using K-maps.

Y = AC + A'B'C

2) Simplify the following Boolean equation using K-maps.

Y = A'B' + A'BC' + (A+C')'

3) Simplify the following Boolean function using K-maps.

$$Y\,(A,\ B,\ C) = \sum_m (0, 1,\ 2, 3, 4, 5)$$

4) Simplify the following Boolean function using K-maps.

$$Y\,(A,\ B,\ C, D) = \sum_m (0, 1, 2, 4, 5, 6, 8, 9, 10, 12, 13)$$

5) Find a minimal Boolean equation for the function with the truth table as shown below. Remember to take advantage of the don't care entries.

A	B	C	D	Y
0	0	0	0	X
0	0	0	1	X
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

6) Find a minimal Boolean equation for the function with the truth table as shown below. Remember to take advantage of the don't care entries.

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	X
0	0	1	1	X
0	1	0	0	0
0	1	0	1	X
0	1	1	0	X
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

7) A circuit has four inputs and two outputs. The inputs A3, A2, A1 and A0 represent a number from 0 to 15. Output P should be TRUE if the number is prime (0 and 1 are not prime, but 2, 3, 5, and so on, are prime). Output D should be TRUE if the number is divisible by 3. Give simplified Boolean equations for each output and sketch a circuit.

8) An M-bit thermometer code for the number k consists of k 1's in the least significant bit positions and M– k 0's in all the more significant bit positions. A *binary-to-thermometer code converter* has N inputs and 2^N–1 outputs. It produces a 2^N–1 bit thermometer code for the number specified by the input.

For example, if the input is 110, the output should be 0111111. Design a 3:7 binary-to-thermometer code converter. Give a simplified Boolean equation for each output, and sketch a schematic.

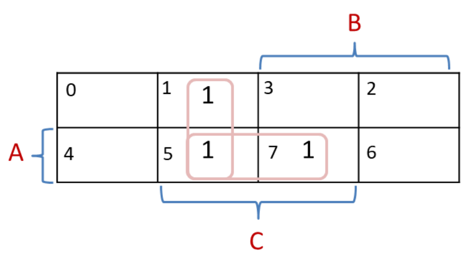
Answers:

1) Simplify the following Boolean equation using K-maps.

Y = AC + A'B'C

Y= ABC + AB'C + A'B'C

$$Y\ (A,\ B,\ C) = \sum\nolimits_{m} (1,\ 5,\ 7)$$



Y =AC + B'C

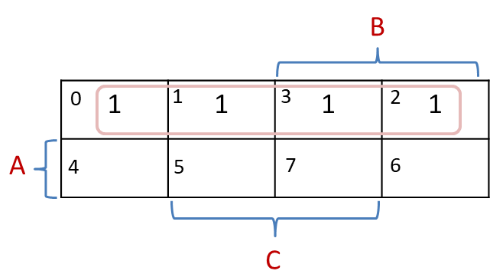
2) Simplify the following Boolean equation using K-maps.

Y = A'B' + A'BC' + (A+C')'

Y = A'B'C + A'B'C' + A'BC' + A'C

Y = A'B'C + A'B'C' + A'BC' + A'BC + A'B'C

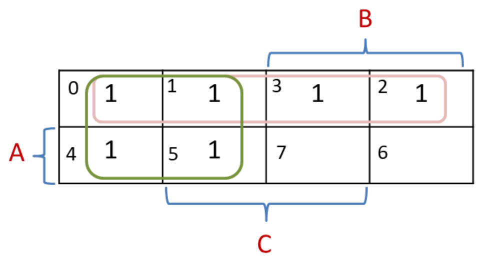
$$Y\ (A,\ B,\ C) = \sum\nolimits_{m} (0, 1,\ 2, 3)$$



Y = A'

3) Simplify the following Boolean function using K-maps.

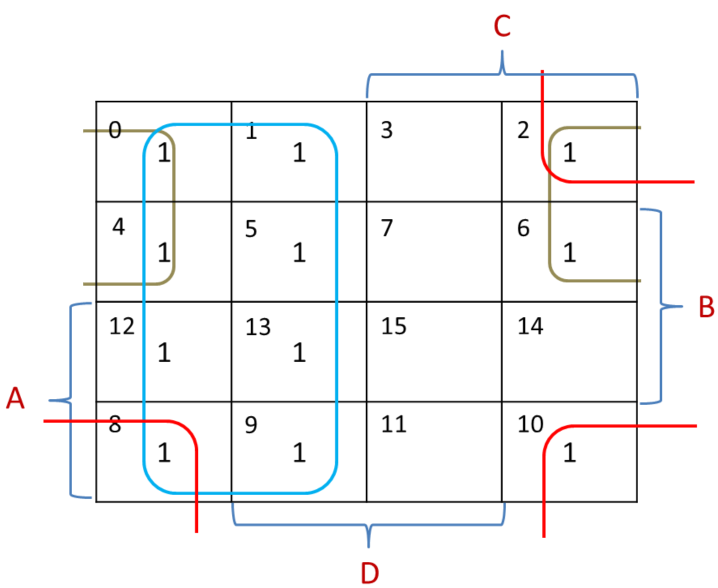
$$Y\ (A,\ B,\ C) = \sum_m (0, 1,\ 2, 3, 4, 5)$$



Y = A' + B'

4) Simplify the following Boolean function using K-maps.

$$Y\ (A,\ B,\ C, D) = \sum_m (0, 1, 2, 4, 5, 6, 8, 9, 10, 12, 13)$$

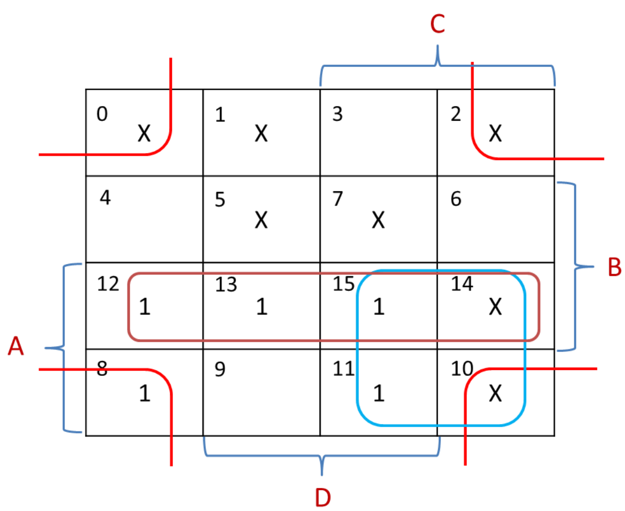


Y = C' + A' D' + B' D'

5) Find a minimal Boolean equation for the function with the truth table as shown below. Remember to take advantage of the don't care entries.

A	B	C	D	Y
0	0	0	0	X
0	0	0	1	X
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

One solution:

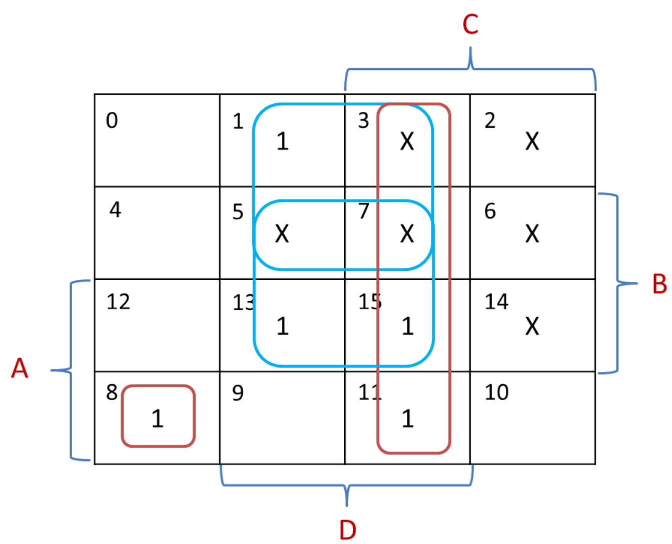


Y = A B + A C + B' D'

6) Find a minimal Boolean equation for the function with the truth table as shown below. Remember to take advantage of the don't care entries.

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	X
0	0	1	1	X
0	1	0	0	0
0	1	0	1	X
0	1	1	0	X
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

One solution:



Y = A B' C' D' + C D + B D + A' D

7) A circuit has four inputs and two outputs. The inputs A3, A2, A1 and A0 represent a number from 0 to 15. Output P should be TRUE if the number is prime (0 and 1 are not prime, but 2, 3, 5, and so on, are prime). Output D should be TRUE if the number is divisible by 3. Give simplified Boolean equations for each output and sketch a circuit.

Decimal Value	A_3	A_2	A_1	A_0	D	P
0	0	0	0	0	0	0
1	0	0	0	1	0	0
2	0	0	1	0	0	1
3	0	0	1	1	1	1
4	0	1	0	0	0	0
5	0	1	0	1	0	1
6	0	1	1	0	1	0
7	0	1	1	1	0	1
8	1	0	0	0	0	0
9	1	0	0	1	1	0
10	1	0	1	0	0	0
11	1	0	1	1	0	1
12	1	1	0	0	1	0
13	1	1	0	1	0	1
14	1	1	1	0	0	0
15	1	1	1	1	1	0

P has two possible minimal solutions:

D

$A_{1:0}$ \ $A_{3:2}$	00	01	11	10
00	0	0	1	0
01	0	0	0	1
11	1	0	1	0
10	0	1	0	0

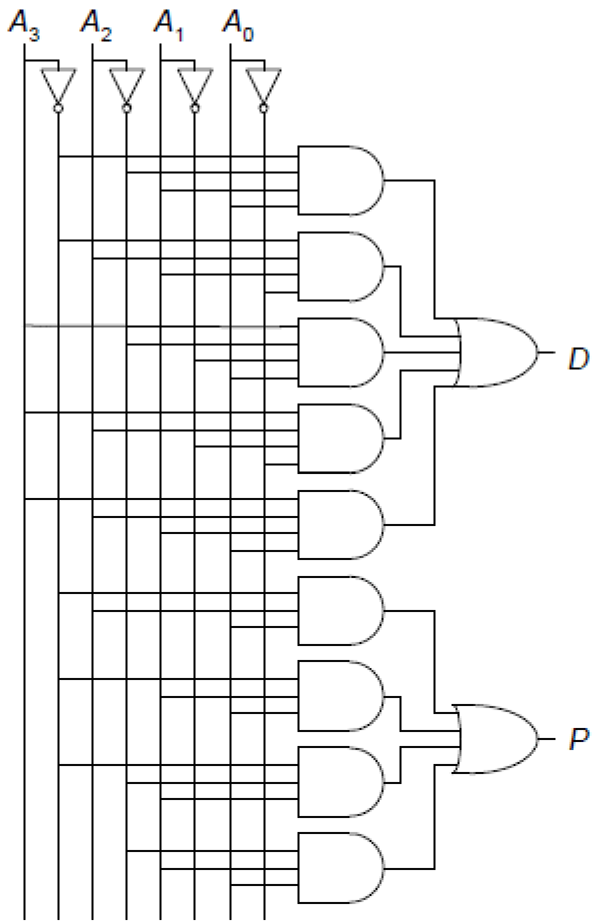
$$D = \bar{A}_3\bar{A}_2A_1A_0 + \bar{A}_3A_2A_1\bar{A}_0 + A_3\bar{A}_2\bar{A}_1A_0 + A_3A_2\bar{A}_1\bar{A}_0 + A_3A_2A_1A_0$$

P

$A_{1:0}$ \ $A_{3:2}$	00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	1	1	0	1
10	1	0	0	0

$$P = \bar{A}_3A_2A_0 + \bar{A}_3A_1A_0 + \bar{A}_3\bar{A}_2A_1 + \bar{A}_2A_1A_0$$

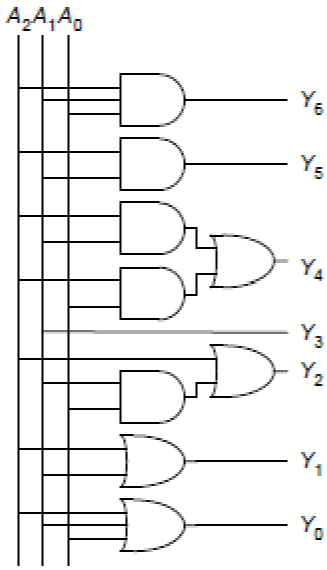
$$P = \bar{A}_3A_1A_0 + \bar{A}_3\bar{A}_2A_1 + \bar{A}_2A_1A_0 + A_2\bar{A}_1A_0$$



8) An M-bit thermometer code for the number k consists of k 1's in the least significant bit positions and M– k 0's in all the more significant bit positions. A *binary-to-thermometer code converter* has N inputs and 2^N–1 outputs. It produces a 2^N–1 bit thermometer code for the number specified by the input.

For example, if the input is 110, the output should be 0111111. Design a 3:7 binary-to-thermometer code converter. Give a simplified Boolean equation for each output, and sketch a schematic.

$$Y_6 = A_2A_1A_0$$
$$Y_5 = A_2A_1$$
$$Y_4 = A_2A_1 + A_2A_0$$
$$Y_3 = A_2$$
$$Y_2 = A_2 + A_1A_0$$
$$Y_1 = A_2 + A_1$$
$$Y_0 = A_2 + A_1 + A_0$$


$A_2 A_1 A_0$
Y_6
Y_5
Y_4
Y_3
Y_2
Y_1
Y_0