



BLG 231E - Digital Circuits Assignment 3

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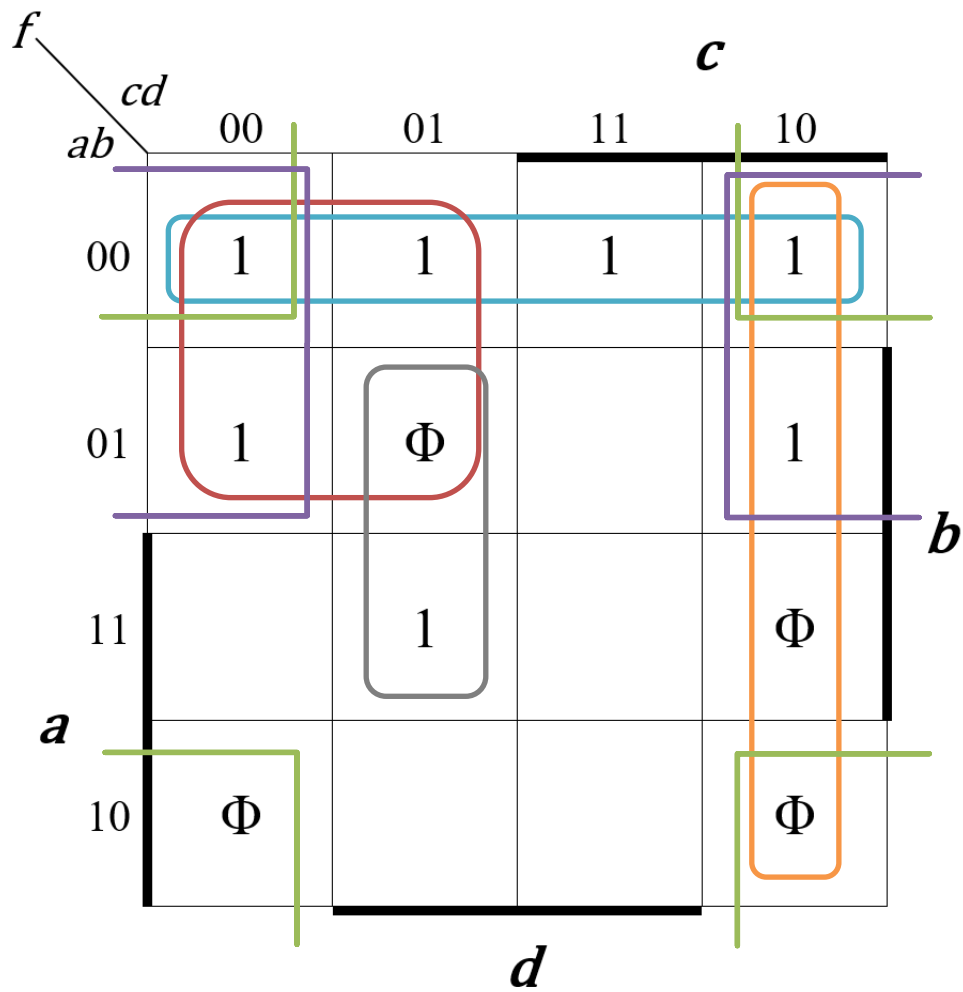
1. The incompletely specified logic function $f(a, b, c, d)$ is given below:

$$f(a, b, c, d) = \cup_1(0, 1, 2, 3, 4, 6, 13) + \cup_\phi(5, 8, 10, 14)$$

- Find the set of all prime implicants of $f(a, b, c, d)$ in SOP form using a Karnaughmap. (25 points)
 - Find the set of all prime implicants of $f(a, b, c, d)$ in SOP form using the Quine-McCluskey method. (25 points)
2. Using the cost criteria below, construct the prime implicant chart for the prime implicants of $f(a, b, c, d)$ in SOP form that you found above in **Question (1)**. Then, simplify it to obtain the minimal covering sum with the lowest cost. Demonstrate and explain each step of the simplification. Provide the total cost and the expression for the function with the lowest cost. (50 points)

Cost criteria: 2 units for each variable and 1 unit for each complement sign.

1.a)



Set of all prime implicants in SOP form: $a'b'$, $a'c'$, $a'd'$, $b'd'$, cd' , $bc'd$

1.b)

1-generating (true)
input combinations

Num.	<i>a b c d</i>	
0	0 0 0 0	✓
1	0 0 0 1	✓
2	0 0 1 0	✓
4	0 1 0 0	✓
8	1 0 0 0	✓
3	0 0 1 1	✓
5	0 1 0 1	✓
6	0 1 1 0	✓
10	1 0 1 0	✓
13	1 1 0 1	✓
14	1 1 1 0	✓

groups with
2 points

Num.	<i>a b c d</i>	
0,1	0 0 0 -	✓
0,2	0 0 - 0	✓
0,4	0 - 0 0	✓
0,8	- 0 0 0	✓
1,3	0 0 - 1	✓
1,5	0 - 0 1	✓
2,3	0 0 1 -	✓
2,6	0 - 1 0	✓
2,10	- 0 1 0	✓
4,5	0 1 0 -	✓
4,6	0 1 - 0	✓
8,10	1 0 - 0	✓
5,13	- 1 0 1	
6,14	- 1 1 0	✓
10,14	1 - 1 0	✓

groups with
4 points

Num.	<i>a b c d</i>
0,1,2,3	0 0 - -
0,1,4,5	0 - 0 -
0,2,4,6	0 - - 0
0,2,8,10	- 0 - 0
2,6,10,14	- - 1 0

Set of all prime implicants in SOP form: $a'b'$, $a'c'$, $a'd'$, $b'd'$, cd' , $bc'd$

2)

prime implicant	$a'b'$	$a'c'$	$a'd'$	$b'd'$	cd'	$bc'd$
symbol	P1	P2	P3	P4	P5	P6
cost	6	6	6	6	5	7
points covered	0,1,2,3	0,1,4	0,2,4,6	0,2	2,6	13

Prime Implicant Chart:

		true points of the function							Cost
		0	1	2	3	4	6	13	
prime implicants	P1	X	X	X	X				6
	P2	X	X			X			6
	P3	X		X		X	X		6
	P4	X		X					6
	P5			X			X		5
	P6							X	7

Step1:

In this chart, 3 and 13 are the distinguished points. Since P1 and P6 are essential prime implicants, the rows and columns covered by P1 and P6 are removed from the chart.

Products P1 and P6 will be included into the final set.

	0	1	2	3	4	6	13	Cost
✓ P1	X	X	X	X				6
P2	X	X			X			6
P3	X		X		X	X		6
P4	X		X					6
P5			X			X		5
✓ P6							X	7

Step2:

In this chart P3 covers P2 and the cost of P3 is equal to the cost of P2. Therefore, the row of P2 is removed from the chart.

Product P2 will not be in the final set.

	4	6	Cost
P2	X		6
P3	X	X	6
P5		X	5

Step3:

In this chart 4 is the distinguished point. Since P3 is an essential prime implicant, the rows and columns covered by P3 are removed from the chart (after that, there is nothing left of the chart).

Product P3 will be included into the final set.

	4	6	Cost
P3	X	X	6
P5		X	5

Selected prime implicants: P1 + P3 + P6

Total cost: $6 + 6 + 7 = 19$

Expression for the function with the lowest cost: $a'b' + a'd' + bc'd$

$f(a, b, c, d) = a'b' + a'd' + bc'd$ is the function with the lowest cost.