CSE 370 – Winter 2008

Homework 3 – Solutions

Grading Breakdown:

1.	CLD-II, Chapter 2, problem 2.31, parts a and b **(½ point for each SOP and POS Expression)**	**3**
2.	CLD-II, Chapter 2, problem 2.35. **(1.5 points for each correct expression)**	**3**
3.	CLD-II, Chapter 2, problem 2.44. **(Truth table: ½ point, Expressions: 4points, Conclusion ½ point)**	**6**
4.	CLD-II, Chapter 3, problem 3.3, part a,b,c. **(1 point per part)**	**3**
5.	Design Problem	**5**
	Total	**20**

Additional Grading details:

Penalties:

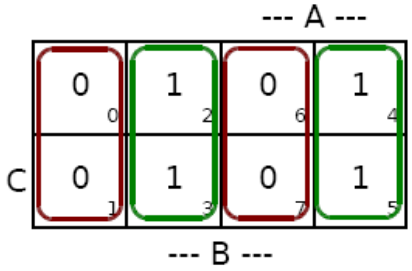
-2 for non standard k-maps

Bonuses:

+2 for word processed and printed work
+1 for very neat handwritten work
+2 for deep insight shown on problems
+2 for a solution to a design or optimization problem that is 50% better than the average

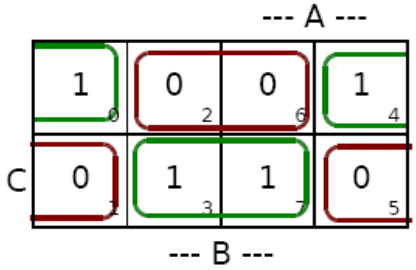
Note: All bonuses and penalties are subject to a maximum score of 20 points and a minimum score of 0.

1) $W(A,B,C)=\overline{A}B\overline{C}+\overline{A}BC+A\overline{B}\overline{C}+A\overline{B}C$



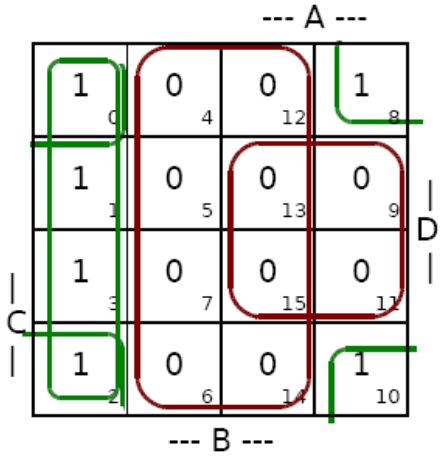
SoP: $W=\overline{A}B+A\overline{B}$
PoS: $W=(A+B)(\overline{A}+\overline{B})$

$X(A,B,C)=\overline{A}\overline{B}\overline{C}+\overline{A}BC+A\overline{B}\overline{C}+ABC$



SoP: $X=\overline{B}\overline{C}+BC$
PoS: $X=(\overline{B}+C)(B+\overline{C})$

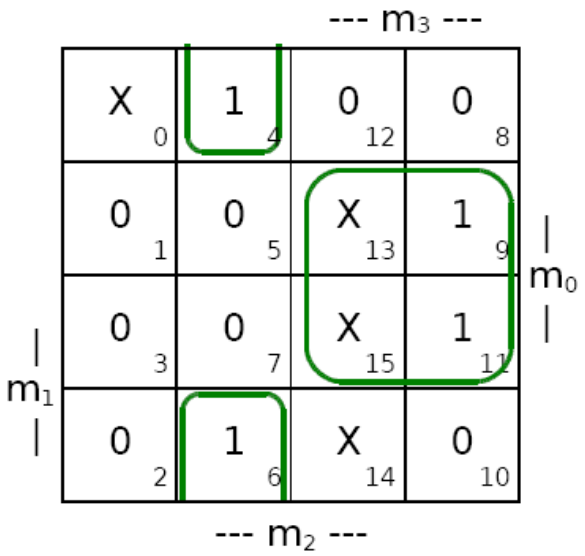
$Y(A,B,C,D)=\overline{A}\overline{B}\overline{C}\overline{D}+\overline{A}\overline{B}\overline{C}D+\overline{A}\overline{B}C\overline{D}+\overline{A}\overline{B}CD+A\overline{B}\overline{C}\overline{D}+A\overline{B}C\overline{D}$



SoP: $X=\overline{A}\overline{B}+\overline{B}\overline{D}$
PoS: $X=(\overline{B})(\overline{A}+\overline{D})$

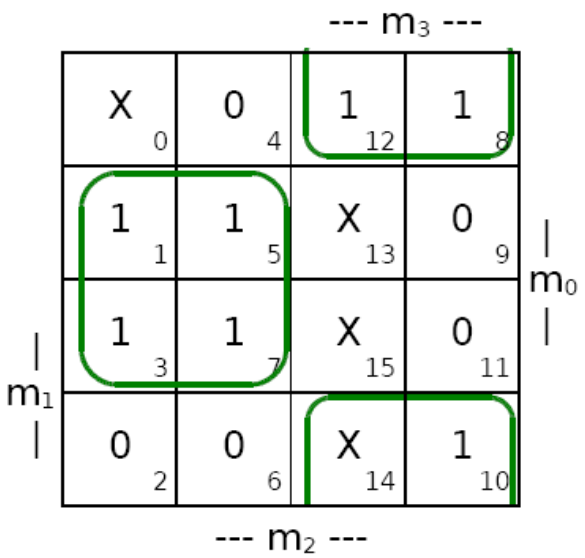
2) See truth table on page 17

d30



$$d30 = m_3 m_0 + \overline{m_3} m_2 \overline{m_0}$$

d31

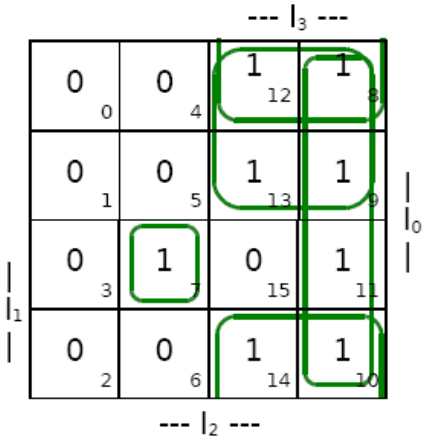


$$d31 = \overline{m_3} m_0 + m_3 \overline{m_0}$$

3) Truth table for increment-by-one

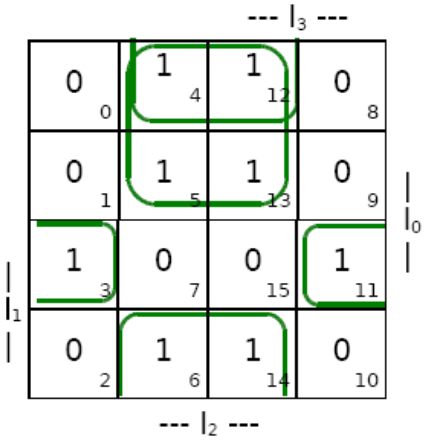
I_3	I_2	I_1	I_0	O_3	O_2	O_1	O_0	I_3	I_2	I_1	I_0	O_3	O_2	O_1	O_0
0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1
0	0	0	1	0	0	1	0	1	0	0	1	1	0	1	0
0	0	1	0	0	0	1	1	1	0	1	0	1	0	1	1
0	0	1	1	0	1	0	0	1	0	1	1	1	1	0	0
0	1	0	0	0	1	0	1	1	1	0	0	1	1	0	1
0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	0
0	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1
0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0

b) O3:



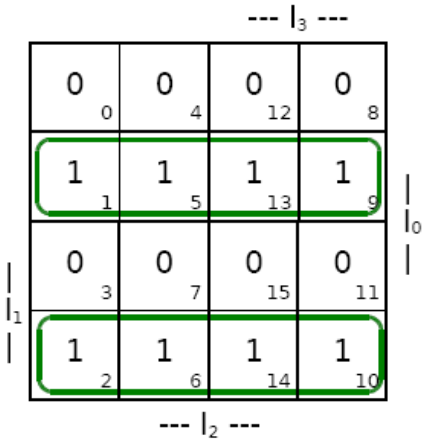
$O_3 = I_3\overline{I_2} + I_3\overline{I_1} + I_3\overline{I_0} + \overline{I_3} I_2 I_1 I_0$

O2:



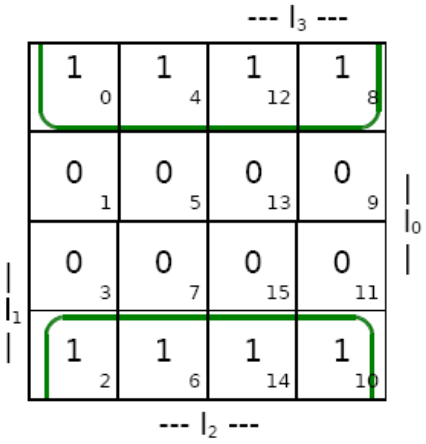
$O_2 = I_2\overline{I_1} + I_2\overline{I_0} + \overline{I_2} I_1 I_0$

O1:



$O_1 = I_1\overline{I_0} + \overline{I_1} I_0$

O0:



$O_0 = \overline{I_0}$

c) Product of Sums

$O_3=(I_3+I_2)(I_3+I_1)(I_3+I_0)(\overline{I_3}+\overline{I_2}+\overline{I_1}+\overline{I_0})$

$O_2=(I_2+I_1)(I_2+I_0)(\overline{I_2}+\overline{I_1}+\overline{I_0})$

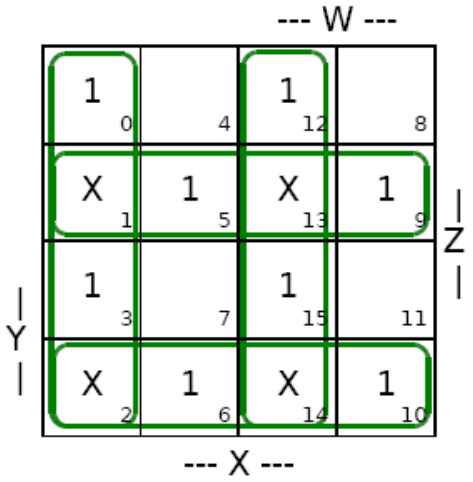
$O_1=(I_1+I_0)(\overline{I_1}+\overline{I_0})$

$O_0=\overline{I_0}$

Both implementations are equal in their number of literals.

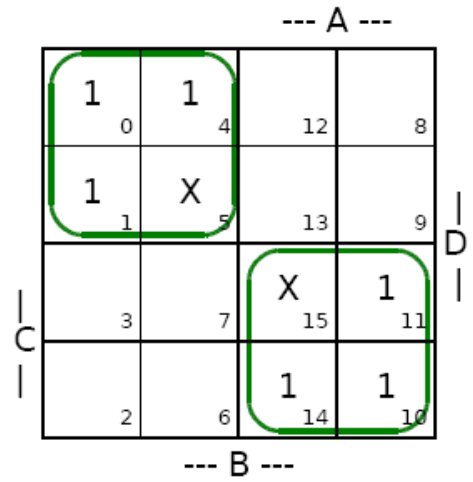
4)

a)



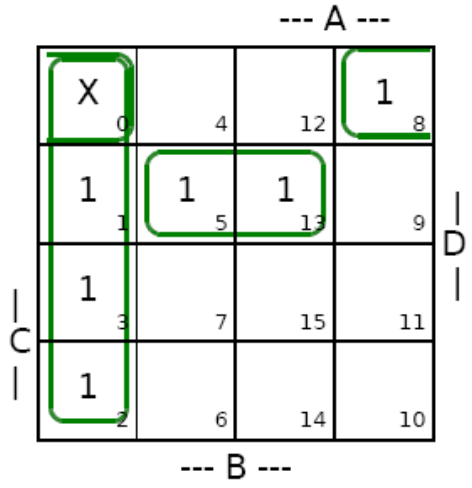
$f=\overline{W}\overline{X}+WX+\overline{Y}Z+Y\overline{Z}$

b)



$f=AC+\overline{A}\,\overline{C}$

c)



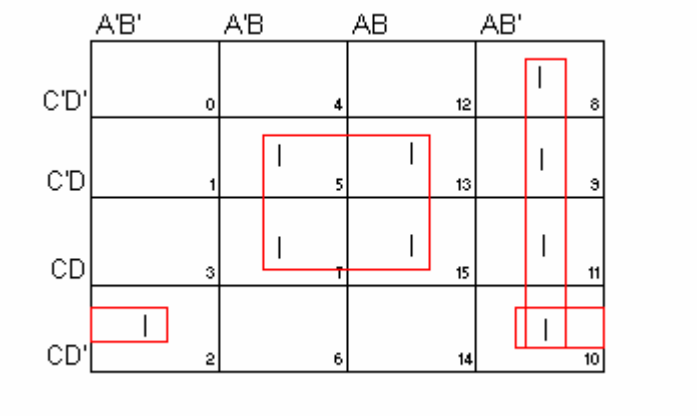
$$f=\overline{A}\,\overline{B}+\overline{B}\,\overline{C}\,\overline{D}+B\,\overline{C}\,D$$

5. Design Problem

Truth Table	♣	ß	Ņ	Σ	F
Min-term Number					
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	1
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	1
11	1	0	1	1	1
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	1

♣ = A
ß = B
Ņ = C
Σ = D

K-Map:



Basic Function:

AB’ + BD + B’CD’

Cost of basic implementation:

2 inverters + 2 2i/p and gates + 1 3i/p And gate + 2 OR Gates

Cost: 4 + 30 + 35 + 30 = 99$
Power: 8 + 20 + 15 + 20 = 63 uW
Area: 4 + 12 + 8 + 12 = 36 sq generic units
Make 2 of the above. Substitute with a 2i/p with 3i/p And gate.

Best Designs - For each metric

Lowest Cost											
Student	Company	Function implemented	Inverters	2 i/p and	3 i/p and	2 i/p or	xor	Cost	Power	Area	Product
Isac Myers	♣ - ß	(B'+D)[(A+B) + D'C]	2	2	0	3	0	79	58	34	
	Σ	(B'+D)[(A+B) + D'C]	5	1	0	4	0	85	70	40	
								164	128	74	1553408
Lowest Power											
Student		Function implemented	Inverters	2 i/p and	3 i/p and	2 i/p or	xor	Cost	Power	Area	Product
Benjamin Lee	♣ - ß	(B'+D)[(A+B) + D'C]	2	2	0	3	0	79	58	34	
	Σ	(B'+D)[(A+B) + D'C]	2	1	1	3	0	99	63	36	
	Total							178	121	70	1507660
Lowest Area											
Student		Function implemented	Inverters	2 i/p and	3 i/p and	2 i/p or	xor	Cost	Power	Area	Product
Benjamin Lee	♣ - ß	(B'+D)[(A+B) + D'C]	2	2	0	3	0	79	58	34	
	Σ	(B'+D)[(A+B) + D'C]	2	1	1	3	0	99	63	36	
	Total							178	121	70	1507660
Best Balanced Design											
Student		Function implemented	Inverters	2 i/p and	3 i/p and	2 i/p or	xor	Cost	Power	Area	
Benjamin Lee	♣ - ß	(B'+D)[(A+B) + D'C]	2	2	0	3	0	79	58	34	
	Σ	(B'+D)[(A+B) + D'C]	2	1	1	3	0	99	63	36	
	Total		4	3	1	6	0	178	121	70	1507660