Problem 1.1

$(230)_{10} \longrightarrow$ octal

$$\begin{array}{r|l}
8 & 230 \\ \hline
8 & 28 \quad , \quad 6 \\ \hline
 & 3 \quad , \quad 4
\end{array}$$

$(230)_{10} = (346)_8$ ✓

$3 \times 64 + 4 \times 8 + 6$

$192 + 32 + 6$

$= 230_{10}$

Proble 1.2

$(19D)_{16} \longrightarrow$ decimal?

$(19D)_{16} = (1 \times 16^2 + 9 \times 16 + 13)_{10}$

$= (256 + 144 + 13)_{10}$

$= \underline{\underline{(413)_{10}}}$

A
B
C
D $= 13$
E $= 14$
F $= 15$

$$\begin{array}{r|l|l}
16 & 413 & \\ \hline
16 & 25 & 13 = D \\ \hline
 & 1 & 9
\end{array}$$

Prob 1.3

$(10\ 0011)_{2s\ \text{complement}}$

Because MSB is 1, the number is $-$ve

$(10\ 0011)_{2s} = -(01\ 1100 + 1)_2$

$= -(01\ 1101)_2$

$= -(1D)_{16}$

$= -(29)_{16}$

Prob 1.4 $\quad -23_{10} \rightarrow$ 2's complement

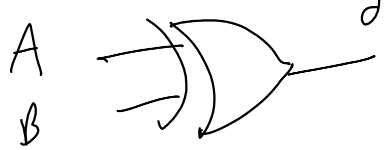
How many bits ?

$-23_{10} = -(17)_{16} = -(01\ 0111)_2$

$= (10\ 1000+1)_{2s}$

$= \underbrace{(10\ 1001)_{2s}}_{\text{Twos compliment}}$

Problem2



$g_1 \equiv$ XOR gate

A	B	g_1
0	0	0
0	1	1
1	0	1
1	1	0

$g_1 = \bar{A}B + A\bar{B}$

$g_2 = \bar{A}C + A\bar{C}$

$Y = g_1\bar{g_2} + \bar{g_1}g_2$

$= (\bar{A}B + A\bar{B})\overline{(\bar{A}C + A\bar{C})} + \overline{(\bar{A}B + A\bar{B})}(\bar{A}C + A\bar{C})$

$$Y = (\bar{A}B + A\bar{B})\left(\underbrace{(A+\bar{C})(\bar{A}+C)}\right) + \left(\underbrace{(A+\bar{B})(\bar{A}+B)}\right)(\bar{A}C + A\bar{C})$$

$$\underbrace{(A+\bar{C})(\bar{A}+C)} = \underbrace{A\bar{A}}_{0} + AC + \bar{C}\bar{A} + \underbrace{\bar{C}C}_{0}$$

$$= AC + \bar{A}\bar{C}$$

] XNOR

$$\underbrace{(A+\bar{B})(\bar{A}+B)} = AB + \bar{A}\bar{B}$$

] XNOR

$$Y = (\bar{A}B + A\bar{B})(AC + \bar{A}\bar{C}) + (AB + \bar{A}\bar{B})(A\bar{C} + \bar{A}C)$$

$$= \underbrace{\bar{A}BAC}_{0} + \bar{A}B\bar{A}\bar{C} + A\bar{B}AC + \underbrace{A\bar{B}\bar{A}\bar{C}}_{0} + ABA\bar{C} + \underbrace{AB\bar{A}C}_{0} + \underbrace{\bar{A}\bar{B}A\bar{C}}_{0} + \bar{A}\bar{B}\bar{A}C$$

$$= \bar{A}B\bar{C} + A\bar{B}C + AB\bar{C} + \bar{A}\bar{B}C$$

$$= (\bar{A}+A)B\bar{C} + (A+\bar{A})\bar{B}C$$

$= B\bar{C} + \bar{B}C =$ XOR gate b/w B and C

$\neq \bar{B}\bar{C} + BC =$ XNOR gate

We have proved $Y \neq \bar{B}\bar{C} + BC$

<u>Problem 3</u> 5-var k map A B C D E

A=0 (B = BC columns 11, 10; C = columns 01, 11; D = rows 11, 10; E = rows 01, 11)

DE \ BC	00	01	11	10
00	1 (0)	0 (4)	0 (12)	1 (8)
01	1 (1)	1 (5)	0 (13)	1 (9)
11	0 (3)	1 (7)	0 (15)	0 (11)
10	0 (2)	1 (6)	1 (14)	0 (10)

A=1 (B = BC columns 11, 10; C = columns 01, 11; D = rows 11, 10; E = rows 01, 11)

DE \ BC	00	01	11	10
00	0 (16)	1 (20)	1 (28)	0 (24)
01	1 (17)	1 (21)	0 (29)	1 (25)
11	0 (19)	1 (23)	0 (31)	0 (27)
10	0 (18)	1 (22)	1 (30)	0 (26)

$PI = \{ \underbrace{\bar{A}\bar{C}\bar{D}}$, $\bar{B}CE$, $\bar{B}CD$, $CD\bar{E}$,

$\Sigma m(0,18,9)$ $\Sigma m(5,7,21,23)$ $\Sigma m(7,6,22,23)$ $\Sigma m(6,14,22,30)$

$\bar{C}\bar{D}E$, $A\bar{B}C$, $AC\bar{D}\bar{E}$,

$\Sigma m(1,9,17,25)$ $\Sigma m(20,21,23,22)$ $\Sigma m(20,28)$

$\bar{B}\bar{D}E$ $\}$

$\Sigma m(1,5,17,21)$

$EPI = \{ \bar{A}\bar{C}\bar{D},\ CD\bar{E},\ \bar{C}\bar{D}E,$
$A C\bar{D}\bar{E} \}$

Remaining minterms are: $m(5, 7, 27, 23)$

Adding $\bar{B}CE$ will complete the cover with the EPIs

$$\underbrace{f(A,B,C,D,E) = \bar{A}\bar{C}\bar{D} + CD\bar{E} + \bar{C}\bar{D}E + AC\bar{D}\bar{E} + \bar{B}CE}_{\text{minimum SOP expression for F}}$$

Problem 4

$$g_1 = \overline{\bar{A}\cdot B} \Rightarrow \bar{g}_1 = \bar{A}\cdot B$$

$$g_2 = \overline{A\cdot C\cdot D} \Rightarrow \bar{g}_2 = A\cdot C\cdot D$$

$$g_3 = E + F + G \Rightarrow \bar{g}_3 = \bar{E}\cdot\bar{F}\cdot\bar{G}$$

$$Y = \overline{g_1 \cdot g_2 \cdot g_3}$$

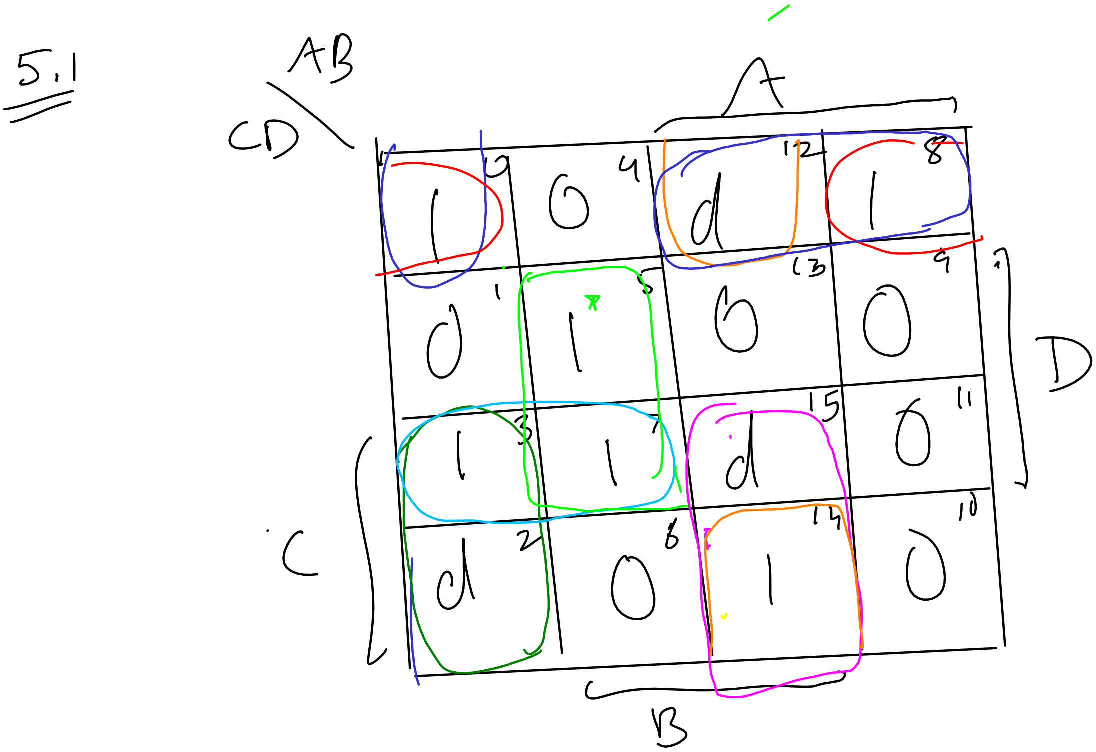
$$= \bar{g}_1 + \bar{g}_2 + \bar{g}_3$$

$$= \bar{A}\cdot B + A\cdot C\cdot D + \bar{E}\cdot\bar{F}\cdot\bar{G}$$

Prob 5

$$Y(A,B,C,D) = \sum m(0,3,5,7,8,14) + \sum d(2,12,15)$$

5.1



PI = { $\bar{A}\bar{B}\bar{D}$ $\sum m(0,2)$, $\bar{B}\bar{C}\bar{D}$ $\sum m(0,8)$, $\bar{A}\bar{B}C$ $\sum m(2,3)$, $\bar{A}CD$ $\sum m(3,7)$, $\bar{A}BD$ $\sum m(5,7)$

ABC $\sum m(14,15)$, $AB\bar{D}$ $\sum m(14,12)$, $A\bar{C}\bar{D}$ $\sum m(8,12)$ }

EPI = { $\bar{A}BD$ }

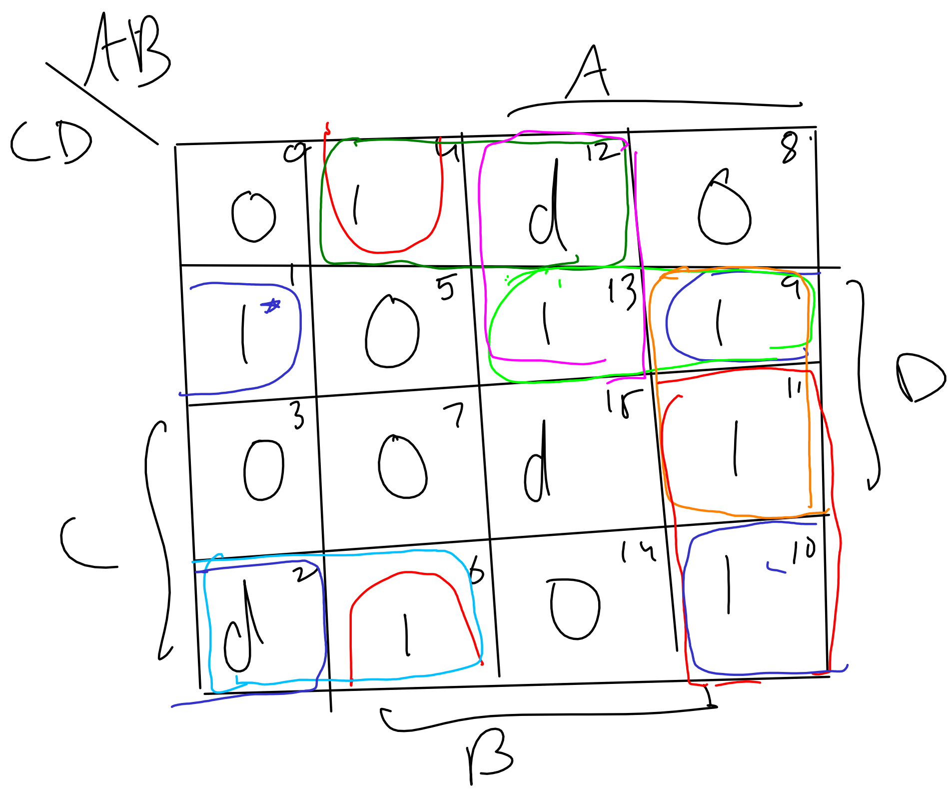
EPI round 2 = { $\bar{A}\bar{B}C$ }

Addnl PI cover = { $\bar{B}\bar{C}\bar{D}$, ABC }

$Y(A,B,C,D) = \bar{A}B\bar{D} + \bar{A}\bar{B}C + \bar{B}\bar{C}D + AB\bar{C}$

$\underbrace{\qquad\qquad\qquad\qquad}_{\text{minimum SOP expression for } Y}$

$\bar{Y}$



$PI = \{ \bar{B}\bar{C}D$, $\sum m(1,9)$; $\bar{A}B\bar{D}$, $\sum m(4,6)$; $B\bar{C}\bar{D}$, $\sum m(4,12)$; $\bar{A}C\bar{D}$, $\sum m(6,2)$;

$A\bar{C}D$, $\sum m(9,13)$; $AB\bar{C}$, $\sum m(12,13)$; $A\bar{B}D$, $\sum m(9,11)$; $A\bar{B}C$, $\sum m(11,10)$;

$\bar{B}C\bar{D}$, $\sum m(10,2)$ $\}$

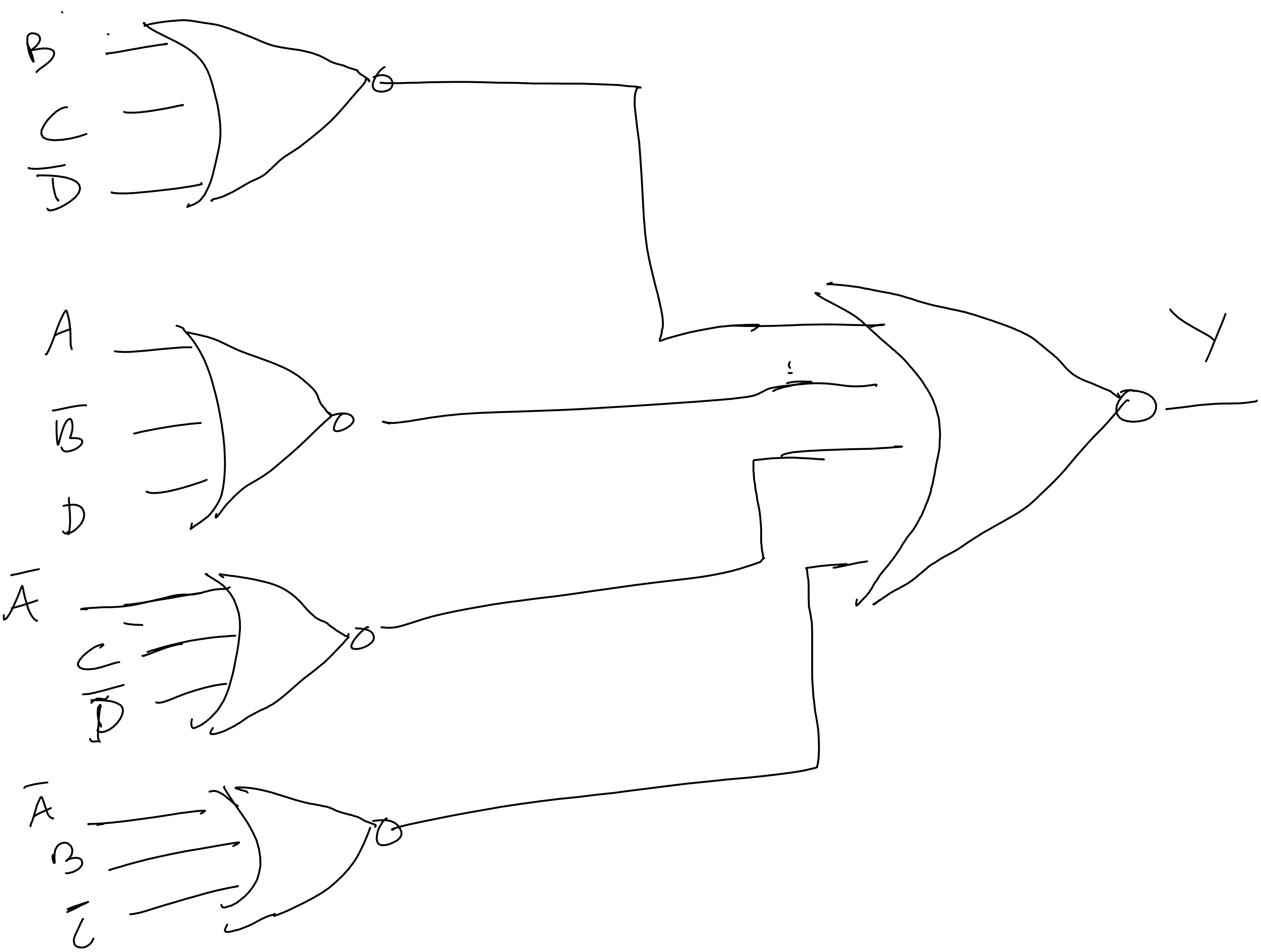
$EPI = \{ \bar{B}\bar{C}D \}$

Addnl PIs for cover $= \{ \bar{A}B\bar{D},\ A\bar{C}D,\ A\bar{B}C \}$

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

$$\underbrace{Y(A,B,C,D) = (B+C+\overline{D})(A+\overline{B}+D)(\overline{A}+C+\overline{D})(\overline{A}+B+\overline{C})}_{\text{minimum POS expression for } Y}$$

5.2 Sketch NOR-NOR



Prob 5.3 Write Y in POS canonical form

$$Y(A,B,C,D) = \sum m(0,3,5,7,8,14) + \sum d(2,12,15)$$

$$= \prod M(1,4,6,9,10,11,13)$$

$$= \underset{m_1}{\left(\overline{\bar{A}\bar{B}\bar{C}D}\right)} \cdot \underset{m_4}{\left(\overline{\bar{A}B\bar{C}\bar{D}}\right)} \cdot \underset{m_6}{\left(\overline{\bar{A}BC\bar{D}}\right)} \cdot \underset{m_9}{\left(\overline{A\bar{B}\bar{C}D}\right)} \cdot$$

$$\cdot \underset{m_{10}}{\left(\overline{A\bar{B}C\bar{D}}\right)} \underset{m_{11}}{\left(\overline{A\bar{B}CD}\right)} \underset{m_{13}}{\left(\overline{AB\bar{C}D}\right)}$$

$$= \underset{M_1}{(A+B+C+\bar{D})} \underset{M_4}{(A+\bar{B}+C+D)} \underset{M_6}{(A+\bar{B}+\bar{C}+D)} \underset{M_9}{(\bar{A}+B+C+\bar{D})} \cdot$$

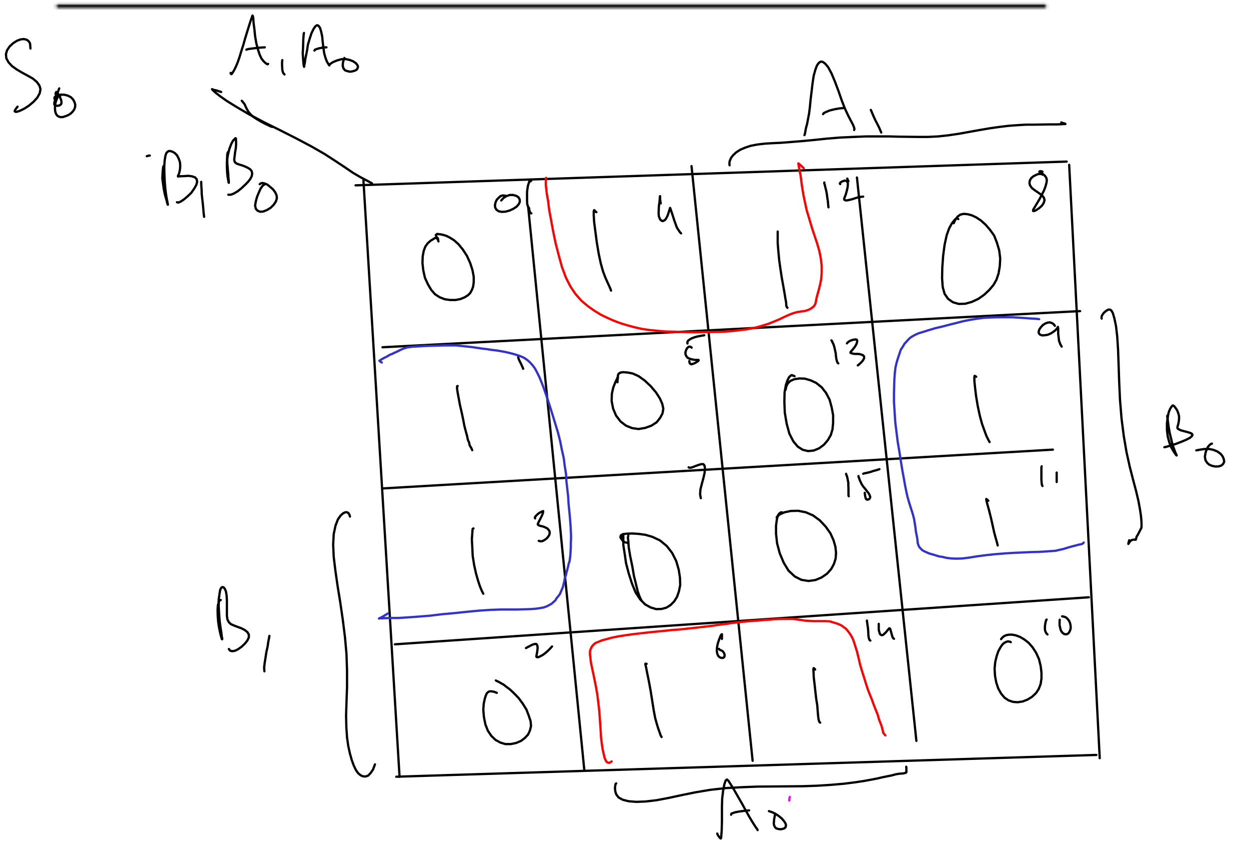
$$\cdot \underset{M_{10}}{(\bar{A}+B+\bar{C}+D)} \underset{M_{11}}{(\bar{A}+B+\bar{C}+\bar{D})} \underset{M_{13}}{(\bar{A}+\bar{B}+C+\bar{D})}$$

Problem 6

$$\begin{array}{lcc} A_1A_0 & 1 & 0 \\ B_1B_0 & 1 & 1 \\ \hline & 0 & 1 \end{array}$$

$C = 1$

A_1	A_0	B_1	B_0	C_1	S_1	S_0	
0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	1
0	0	1	0	0	1	0	2
0	0	1	1	0	1	1	3
0	1	0	0	0	0	1	4
0	1	0	1	0	1	0	5
0	1	1	0	0	1	1	6
0	1	1	1	1	0	0	7
1	0	0	0	0	1	0	8
1	0	0	1	0	1	1	9
1	0	1	0	1	0	0	10
1	0	1	1	1	0	1	11
1	1	0	0	0	1	1	12
1	1	0	1	1	0	0	13
1	1	1	0	1	0	1	14
1	1	1	1	1	1	0	15



$$PI_s = \{ A_0\overline{B_0},\ \overline{A_0}B_0 \}$$

$$= EPI_s$$

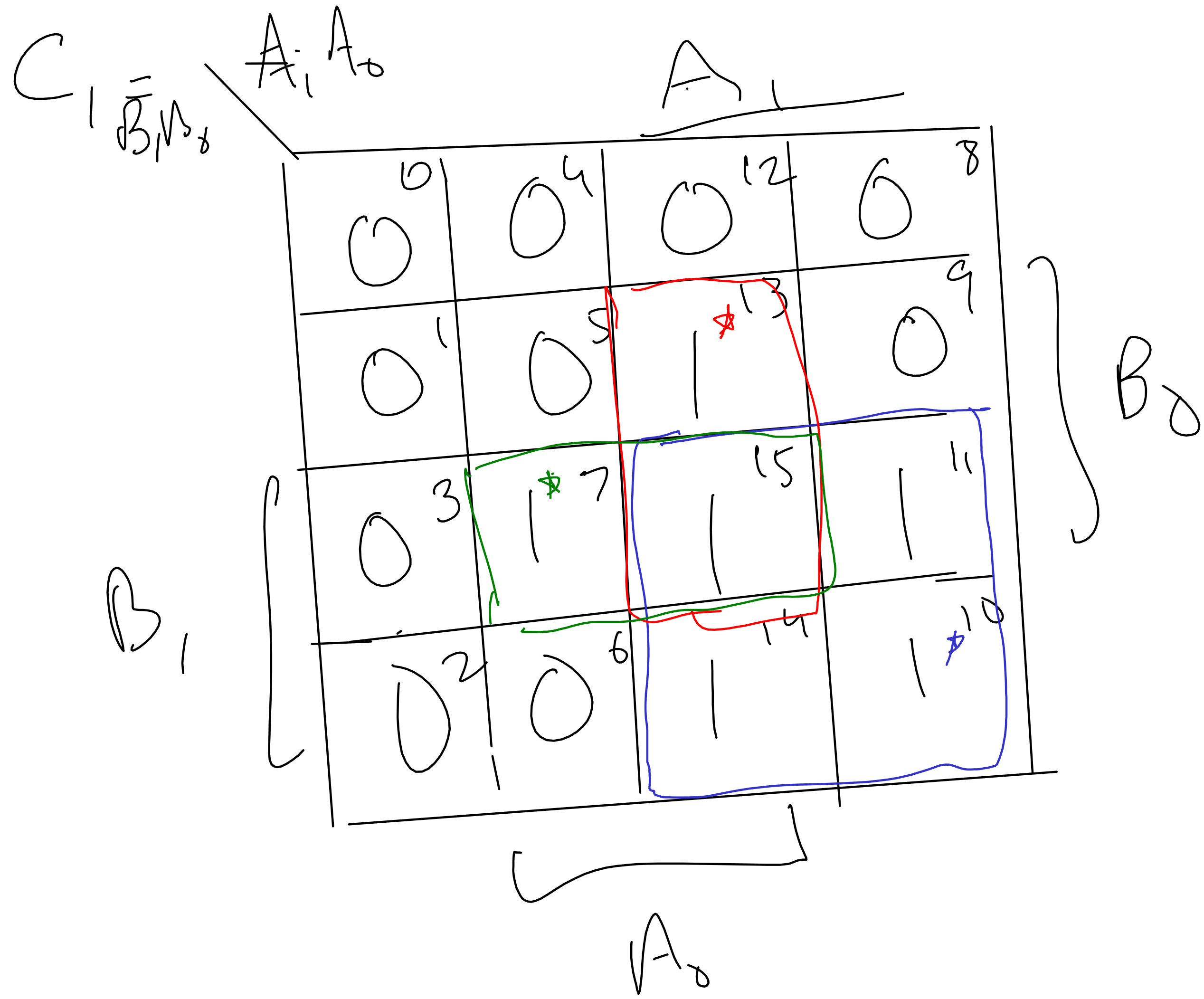
$$S_0 = A_0\overline{B_0} + \overline{A_0}B_0$$

S_1

$B_1B_0 \backslash A_1A_0$	00	01	11	10
00	0^{0}	0^{4}	1^{12}	1^{8}
01	0^{1}	1^{5}	0^{13}	1^{9}
11	1^{3}	0^{7}	1^{15}	0^{11}
10	1^{2}	1^{6}	0^{14}	0^{10}

A_1, A_0, B_0, B_1

$$S_1 = \overline{A_1}\,\overline{A_0}B_1 + \overline{A_1}A_0\overline{B_1}B_0 + \overline{A_1}B_1\overline{B_0} + A_1\overline{B_1}\,\overline{B_0} + A_1A_0B_1B_0 + A_1\overline{A_0}\,\overline{B_1}$$



$$C_1 = A_1 B_1 + A_1 A_0 B_0 + A_0 B_1 B_0$$