SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with 'A' Grade by NAAC

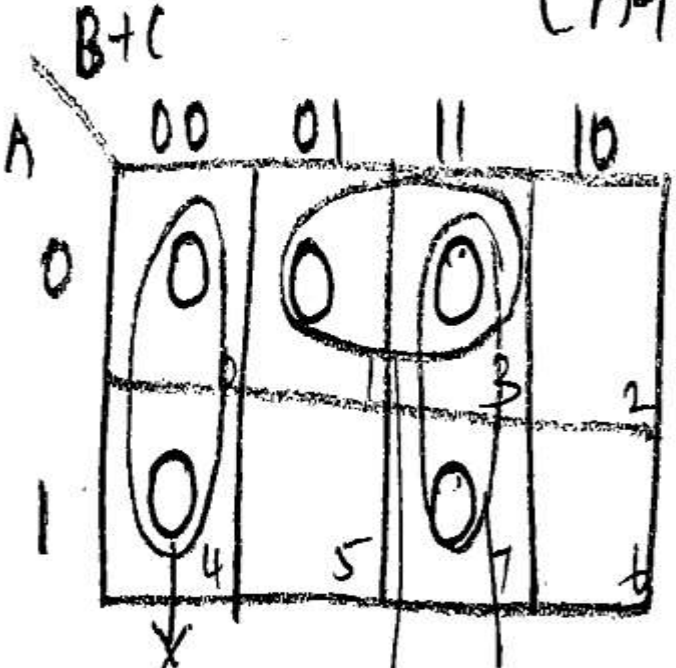
Lecture session – UNIT 2

Topic: Karnaugh map continuation.... And Tabulation method

By
V.GEETHA
ASSISTANT PROFESSOR/EEE
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY
CHENNAI-119

minimize the expression

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



$A+B+\bar{C} = 001 \Rightarrow M_1$

$A+\bar{B}+\bar{C} = 011 \Rightarrow M_3$

$\bar{A}+\bar{B}+\bar{C} = 111 \Rightarrow M_7$

$\bar{A}+B+C = 100 \Rightarrow M_4$

$A+B+C = 000 \Rightarrow M_0$

$g_1 = B+C$ $\quad g_2 = \bar{B}+\bar{C}$

$g_3 = A+\bar{C}$

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

Minimize the following expressions in POS form.

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

A+B \ C+D	00	01	11	10
00	0			
01			0	0
11	0	0	0	0
10	0			

$\bar{A}+\bar{B}+C+D = 1100 = 12$

$\bar{A}+\bar{B}+\bar{C}+D = 1110 = 14$

$\bar{A}+\bar{B}+\bar{C}+\bar{D} = 1111 = 15$

$\bar{A}+B+C+D = 1000 = 8$

$A+\bar{B}+\bar{C}+D = 0110 = 6$

$A+\bar{B}+\bar{C}+\bar{D} = 0111 = 7$

$A+B+C+D = 0000 = 0$

$\bar{A}+\bar{B}+C+\bar{D} = 1101 = 13$

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

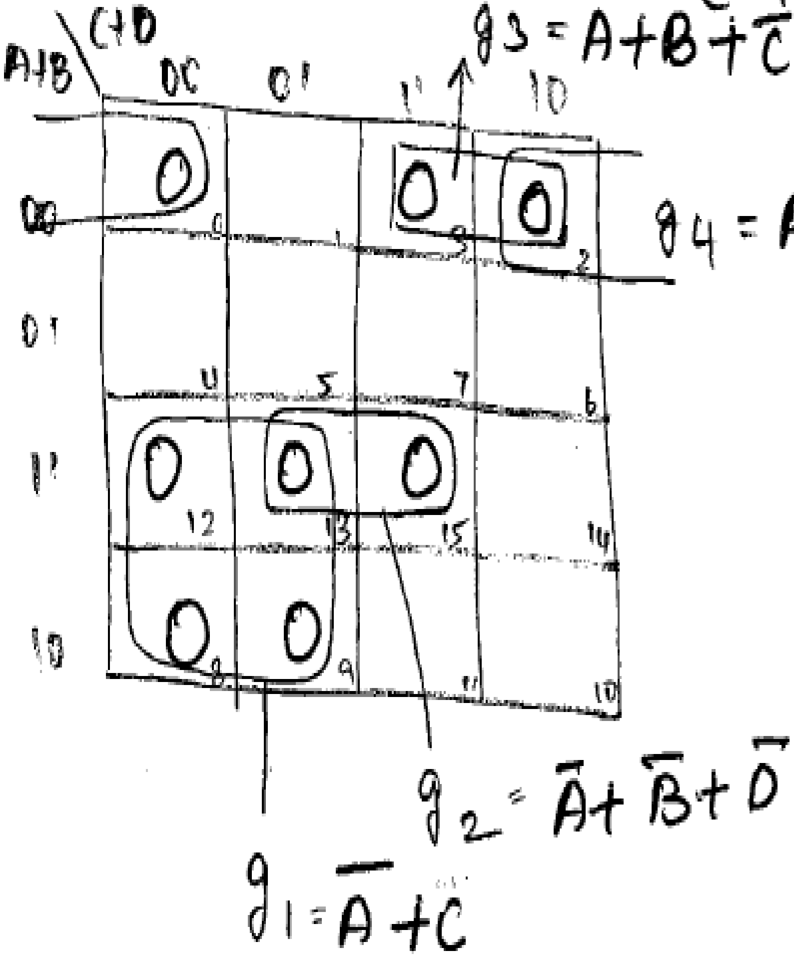
$g_2 = \bar{A}+\bar{B}$

$g_3 = (B+C+D)$

Ans: $y = (B+C+D)(\bar{B}+\bar{C})(\bar{A}+\bar{B})$

Reduce the following function using K-map techniq

$$F(A,B,C,D) = \pi M(0,2,3,8,9,12,13,15).$$



Answer!

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

Obtain the minimal product of sum for $f = \sum(0,2,3,6,7) + d(8,10,11,15)$.

AB \ CD	00	01	11	10
00		0		
01	0	0		
11	0	0	X	0
10	X	0	X	X

$g_2 = C + \bar{D}$

$g_3 = \bar{B} + C$

$g_1 = \bar{A}$

Answer :

$f = \bar{A} \cdot (\bar{B} + C) \cdot (C + \bar{D})$.

Reduce the following using k-map $f(A,B,C,D) = \prod(0,3,4,7,8,10,12,14) + d(2,6)$.

AB \ CD	00	01	11	10
00	0		0	X
01	0		0	X
11	0			0
10	0			0

$g_1 = D$

$g_2 = A + \bar{C}$

Answer

$F(A,B,C,D) = (A + \bar{C}) \cdot D$.

The limitations of K-Map or The limitations of Karnaugh Map’s are :

The limitation to a K-map is that it is only really efficient to use with few variables (small bits) and gets highly confusing to minimize logic which has more variables(variable numbers > 5).

It is so difficult to visualize for more than five variables using K-Map. A 4 variable K-map is 2 dimensional and easy to visualize.

On the other hand, A 5 variable is three dimensional and it is still manageable from a visualization standpoint, because the 2 states of the 5th variable only require visually moving from one plane to the next, without moving in the x or y directions of either plane.

Just getting equations correct with more than 5 variables is difficult enough using the K map, much less considering an optimum set of terms.

TABULATION METHOD
OR
QUINE MC CLUSKY METHOD

Simplify the given Boolean function by using a Tabulation method

F(A,B,C,D)=m(0,2,3.,6,7,8,10,12 ,13)

Solution.

Step 1: group the min terms and its binary representation.

MIN TERMS	BINARY REPRESENTATION
mo	0000
m2	0010
m3	0011
m6	0110
m7	0111
m8	1000
m10	1010
m12	1100
m13	1101

Step 2: Arrange the min terms and its binary representation according to number of ones in the binary representation

MIN TERMS	BINARY REPRESENTATION
mo	**0000**
m2	0010
m8	1000
m3	**0011**
m6	**0110**
m10	**1010**
m12	**1100**
m7	0111
m13	1101

Step 3: Check for the prime implicant – I, by merging the minterms

Checking for prime implicants	
(0,2)	**00_0**
(0,8)	**_000**
(2,3)	**001_**
(2,6)	**0_10**
(2,10)	**_010**
(8,10)	**10_0**
(8,12)	**1_00**
(3,7)	**0_11**
(6,7)	**011_**
(12,13)	**110_**

Step 4: Check for the prime implicant – II, by merging the prime implicant -I

Checking for prime implicants-II	
(0,2)	**00_0**
(0,8)	**_000**
(2,3)	**001_**
(2,6)	**0_10**
(2,10)	**_010**
(8,10)	**10_0**
(8,12)	**1_00**
(3,7)	**0_11**
(6,7)	**011_**
(12,13)	**110_**

Step 5:

(0,2,8,10)	**_0_0**
(2,3,6,7)	**0_1_**
(0,8,2,10)	**_0_0**
(2,3,6,7)	**0_1_**
(8,12)	1_00
(12,13)	110_

Step 6:

(0,2,8,10)	**_0_0**
(2,3,6,7)	**0_1_**
(8,12)	1_00
(12,13)	110_

									√	√
			√	√	√	√				
		√	√				√	√		
	(A,B,C,D)	**0**	**2**	**3**	**6**	**7**	**8**	**10**	**12**	**13**
(8,12)	**AC’D’**						**X**		**X**	
(12,13)	**ABC’**								**X**	**X**
(0,2,8,10)	**B’D’**	**X**	**X**				**X**	**X**		
(2,3,6,7)	**A’C**		**X**	**X**	**X**	**X**				
FINDING ESSENTIAL PRIME IMPLICANTS(EPI)										

The final expression is

F(A,B,C,D)=ABC’+B’D’+A’C

Simplify the given Boolean function by using a Tabulation method

$F(A,B,C,D)=m(1,2,3,5,9,12,14,15)+d(4,8,11)$

Solution.

Step 1: group the min terms and its binary representation.

MIN TERMS	BINARY REPRESENTATION
m1	0001
m2	0010
m3	0011
m5	0101
m9	1001
m12	1100
m14	1110
m15	1111
dm4	**0100**
dm8	**1000**
dm11	**1011**

Step 2: Arrange the min terms and its binary representation according to number of ones in the binary representation

MIN TERMS	BINARY REPRESENTATION
m1	0001
m2	0010
dm4	0100
dm8	1000
m3	0011
m5	0101
m9	1001
m12	1100
m14	1110
dm11	1011
m15	1111

Step 3: Check for the prime implicant – I, by merging the min terms

Checking for prime implicants	
(1,3)	00_1
(1,5)	0_01
(1,9)	_001
(2,3)	001_
(4,5)	010_
(4,12)	_100
(8,9)	100_
(8,12)	1_00
(3,11)	_011
(11,15)	1_11
(14,15)	111_
(12,14)	11_0
(9,11)	10_1

Step 4:Checking for prime implicants

Checking for prime implicants	
(1,3,9,11))	_0_1
(1,5)	0_01
(2,3)	001_
(4,5)	010_
(4,12)	_100
(8,9)	100_
(8,12)	1_00
(11,15)	1_11
(14,15)	111_
(12,14)	11_0

Step 5: Finding essential prime implicants

		√	√	√	√	√	√	√	√			√
		1	2	3	5	9	12	14	15	d4	d8	d11
√ (1,3,9,11)	_0_1	x		x		x						x
(1,5) √	0_01	x			x							
(2,3) √	001_		x	x								
(4,5)	010_				x					x		
(4,12)	_100						x			x		
(8,9)	100_					x					x	
(8,12)	1_00						x				x	
(11,15)	1_11								x			x
(14,15) √	111_							x	x			
(12,14) √	11_0						x	x				

Final Reduced expression is

(1,3,9,11)	_0_1	B’D
(1,5)	0_01	A’C’D
(2,3)	001_	A’B’C
(14,15)	111_	ABC
(12,14)	11_0	ABD’

F(A,B,C,D)= B’D+A’C’D+A’B’C+ABC+ABD’

1. Simplify the following expression using K-Map and implement using NAND -NAND or NOR-NOR implementation
   $F(A,B,C,D)=\Sigma m(0,1,2,3,11,12,14,15)$
   $F(A,B,C,D)=\Sigma m(4,5,7,8,9,10,11,14,14)+dm(1,4,13)$
   $F(W,X,Y,Z)=\Pi m(4,5,6,7,8,12)+d(1,2,3,9,11,14)$
   $F(A,B,C)=\Pi m(0,1,2,3,4,7)$
2. Simplify the following expression using Tabulation method
   $F(A,B,C,D)=\Sigma m(0,1,2,3,4,6,8,10,12,14)$
   $F(A,B,C,D)=\Sigma m(0,1,3,6,7,9,13,14,15)$
3. State the limitations of the Karnaugh map.
4. Brief note on the steps to simplify the POS expression.
5. Convert the given expression to standard form
   $Y=A.(A+B+C)$
   $F(A,B,C)=(A+B)(B+C)(A+C)$
   $F=AB+C'D+AB'C$
   $F(X,Y,Z)=(xy+z')(y+xz')$

EXTRA PRACTICE QUESTION(not for assignment)

1.Minimise the function below using the tabular method of simplification:

Z = f(A,B,C,D) = + C + ACD + AC + BCD + BC + CD

2.Using the tabular method of simplification, find all equally minimal solutions for the function below.

Z = f(A,B,C,D) = (1,4,5,10,12,14)

http://www.ee.surrey.ac.uk/Projects/Labview/minimisation/tabular.html

Thank you