COL215L: Digital Logic & System Design

Lecture 7: Combinational Circuits (Cont.)

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Canonical Representation

- Sum of minterms

$f = a'bc'd + ab'cd$

OR

$5 \quad 11$

$f = \sum m(5, 11)$

- Product of maxterms

$f = a + b$

a	b	f

a	b	c	d	f

a b c d

f = 0

a, b, c, d

$a=0,\ b=1,\ c=0,\ d=1$

$f=1 \rightarrow a'bc'd$ minimum term

$a=1,\ b=0,\ c=1,\ d=1$

$f=1 \rightarrow ab'cd$

$2^3 + 2^1 + 2^0$

$$\begin{array}{cccc} 2^3 & 2^2 & 2^1 & 2^0 \\ a & b & c & d \end{array} = 11$$

decimal

$5 \leftarrow 0 \quad 1 \quad 0 \quad 1$

product of max term

$$f = (a' + b' + c' + d')(a' + b' + c' + d')$$

$f = 0$, $a = 1$, $b = 1$, $c = 0$, $d = 0$

$(a' + b' + c' + d')$

$\boxed{f = 0}$, $a = 0$, $b = 0$, $c = 1$, $d = 1$

$(a' + b' + c' + d')$

$2^3 \quad 2^2 \quad 2^1 \quad 2^0$

$a \quad b \quad c \quad d$

$2^3 + 2 + 0 + 0 = 12$

$0 + 0 + 2^1 + \cancel{2}1 = 3$

$$\boxed{f = \prod M(3, 12)}$$

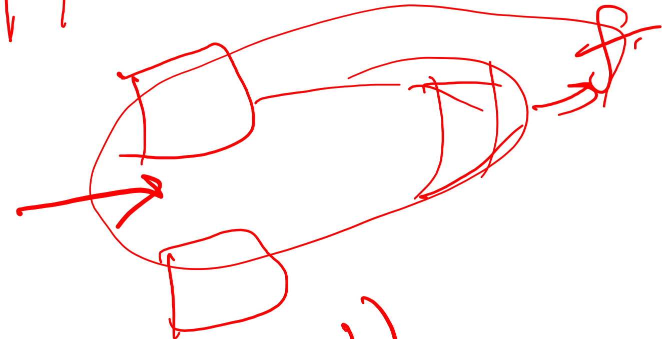
Minterms of $f(a, b, c, d)$

$\boxed{\text{Duality}}$, f

Minimization Objectives

- Cost/area
- Time

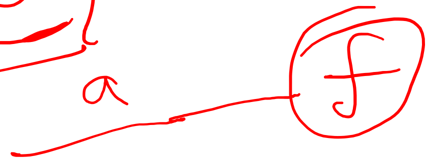
$$\boxed{f = a \cdot b + a b'}$$



$$= a(b + b')$$

$$= a \cdot 1$$

$$\boxed{f = a}$$



Karnaugh Map

- y = f(a,b,c,d) = Σ (0,3,4,7,8,11,15)

sum of minterm

function

ab \ cd	00	01	11	10
00	1		1	
01	1		1	
11			1	
10	1		1	

$y = a'b'c'd' + a'b'cd + a'bc'd' + \ldots$

0, 8

$a'b'c'd' + ab'c'd'$

$= (a'+a)\cdot b'c'd'$

$= b'c'd'$

$a + a' \rightarrow 1$

$a + a = a$

$a'b'c'd'$ (0) $+ a'bc'd'$

$= a'c'd'(b'+b)$

$= a'c'd'$

cd

0, 8

$y = a'c'd' + b'c'd' + cd$

Karnaugh Map (Cont.)

- $y = f(a,b,c,d) = \Pi\ (1,5,9,13,15)$

ab \ cd	00	01	11	10
00		0		
01		0		
11		0	0	
10		0		

$y = (a' + b' + d') \cdot (c + d')$

Challenges with K-Map

- K-Map
  - A graphical method and thus not suitable for large no. of variables
  - Not suitable for programming

- QM (Quine-Mcluskey) method
  - Does not suffer from these disadvantages