

Exam 1 Review

1. CMOS Gates

2. Boolean Algebra

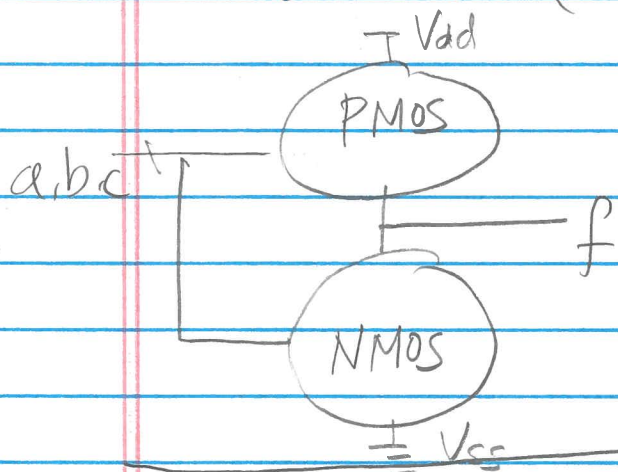
3. Truth Table

4. K Map

5. Universal Set of Gates

1. CMOS Gates (PMOS/NMOS)

Ex: $f(a,b,c) = (a+bc)'$: CMOS



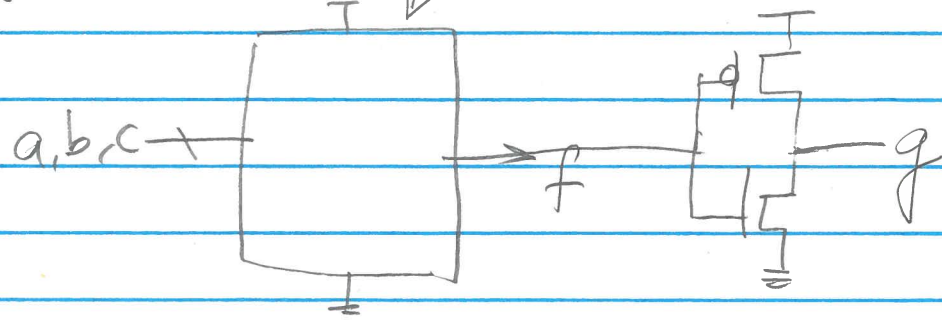
$$a+bc=0, f=1$$

$$(a+bc)'=1$$

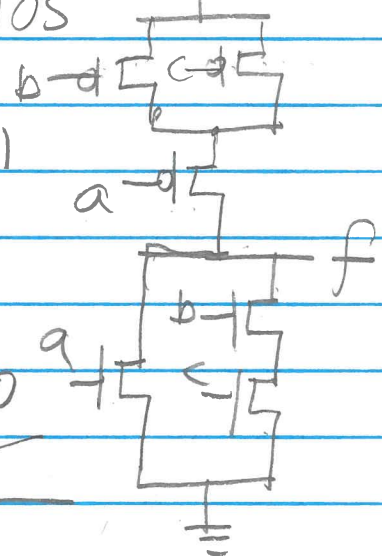
$$a'(b'+c')=1$$

$$a+bc=1, f=0$$

$$g(a,b,c) = a+bc$$



NAND, NOR,
NOT (AND/OR) logic



2. Boolean Algebra

(+ , -) 2 input oper.
1 input oper

$$x + x' = 1 \quad x \cdot x' = 0,$$

$$(x')' = x \Rightarrow \text{The complement is unique.}$$

De Morgan's law

$$(x+y)' = x'y'$$

Proof:

To Show $\begin{cases} (x+y) + x'y' = 1 \\ (x+y) \cdot x'y' = 0 \end{cases} \Rightarrow \text{to prove that } (x+y)' = x'y'$

① LHS

$$\begin{aligned} & (x+y+x') \cdot (x+y+y') \\ &= (1+y)(1+x) \\ &= 1 \cdot 1 = 1 \end{aligned}$$

$$\begin{aligned} \text{② } & (x+y) \cdot x'y' \\ &= x \cdot x'y' + y \cdot x'y' \\ &= 0y' + 0x' = 0 \end{aligned}$$

3 Truth Table Very powerful eng. tool,

$f(a,b,c)$

id	a	b	c
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

$f(0,0,0)$

$\rightarrow$ K map $\rightarrow$ Logic

Tool: Validate your solution

Cover all case!

$f(1,1,1)$

4. K Map

Ex.

	<u>b</u>			
	0	1	2	3
c	0	1	0	1
	1	0	1	0
	<u>a</u>			

Primes:

$$\Sigma m(0,2), E$$

$$\Sigma m(2,3), NE$$

$$\Sigma m(3,7), NE$$

$$\Sigma m(5,7), NE$$

All min exp (Sof P)

$$f(a,b,c) : \Sigma m(0,2) + \Sigma m(3,7) : a'c' + bc$$

$$\Sigma m(0,2) + \Sigma m(5,7) : a'c' + ac$$

	<u>b</u>			
	0	1	2	3
c	0	1	0	1
	1	0	1	0
	<u>a</u>			

Primes

$$\Sigma m(\textcircled{0},2), E$$

$$\Sigma m(2,6), NE$$

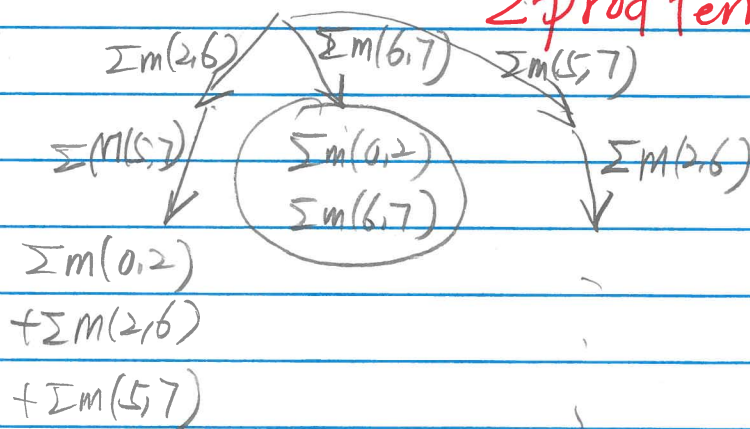
$$\Sigma m(6,7), NE$$

$$\Sigma m(5,7), NE$$

$$f(a,b,c) : \Sigma m(0,2) + \Sigma m(6,7)$$

$$a'c' + ab$$

2 prod terms, 4 literals



K Map b (SofP)

	0	1	2	3	4	5	6	7	8	9
c	0	1	2	3	4	5	6	7	8	9

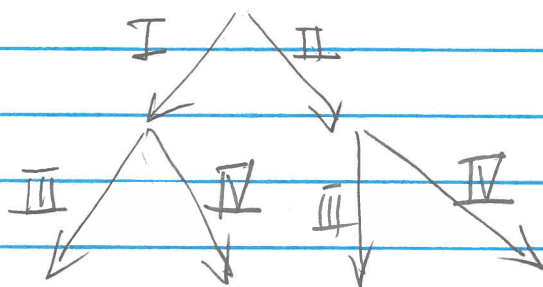
Primes:

I $\Sigma m(0,2)$ NE

II $\Sigma m(0,4)$ NE

III $\Sigma m(2,3)$ NE

IV $\Sigma m(3,7)$ NE



$$\begin{aligned}
 & \left(\Sigma m(0,2) + \Sigma m(2,3) \right) + \left(\Sigma m(0,4) + \Sigma m(3,7) \right) \\
 & \left(\Sigma m(0,2) + \Sigma m(2,3) \right) + \left(\Sigma m(0,4) + \Sigma m(3,7) \right)
 \end{aligned}$$

Ex: $\begin{array}{c|c|c|c|c} & \text{b} & & & \\ \hline \text{P} & 1 & 2 & 6 & 9 \\ \hline \text{c} & 0 & 3 & 7 & 5 \\ \hline & \text{a} & & & \end{array}$ P of Sums

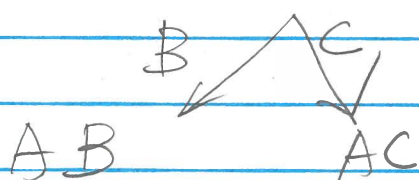
	b			
P	1	2	6	9
c	0	3	7	5
	a			

Prims:

A $\pi M(1, 3, 5, 7)$ E

B $\pi M(2, 3, 6, 7)$ NE

C $\pi M(4, 5, 6, 7)$ NE



$$f(a, b, c) = \pi M(1, 3, 5, 7) \pi(4, 5, 6, 7)$$

$$c' \cdot a'$$

$$\pi M(1, 3, 5, 7) \pi(2, 3, 6, 7)$$

$$c' b'$$

A set of gates : We can construct AND, OR, NOT from the gates in the set, then it is universal

5. Universal Set of Gates

{NAND} {NOR} {XOR, AND} ...

Ex.

	<u>b</u>		
	0	1	
<u>c</u>	0	1	
	0	1	
	0	1	
	0	1	
	0	1	
	0	1	

a

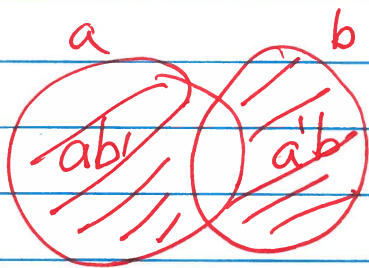
{XOR, AND, NOT}

$$a \oplus b = a'b + ab'$$

Primes:

$$\Sigma m(1, 3, 5, 7) = c$$

$$\Sigma m(6, 7) = ab$$



$$f(a, b, c) = c \oplus (ab)$$

1 prod, 1 XOR, 3 literals

{AND, OR, NOT} S of P.

Primes: $\Sigma m(1, 3) = E$

$$\Sigma m(1, 5) = E$$

$$\Sigma m(6) = E$$

$$f(a, b, c) = \Sigma m(1, 3) + \Sigma m(1, 5) + \Sigma m(6)$$

$$a'c + bc + abc'$$

3 terms 7 literals.

$\{f(x,y,z) = x+y+z'\}$ is universal

