UF Herbert Wertheim College of Engineering
Department of Electrical & Computer Engineering
UNIVERSITY *of* FLORIDA

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EEL3701C - Fall 2025

HW3: Combinational Logic and Components

1. ***Turn K-maps back into a truth table:*** For each of the following, find the truth tables corresponding to the functions defined by the K-maps:

(a)

BC \ A	0	1
00	1	1
01	1	0
11	1	1
10	0	0

A	B	C	output
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

(b)

CD \ AB	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	1	1	1
10	0	1	0	0

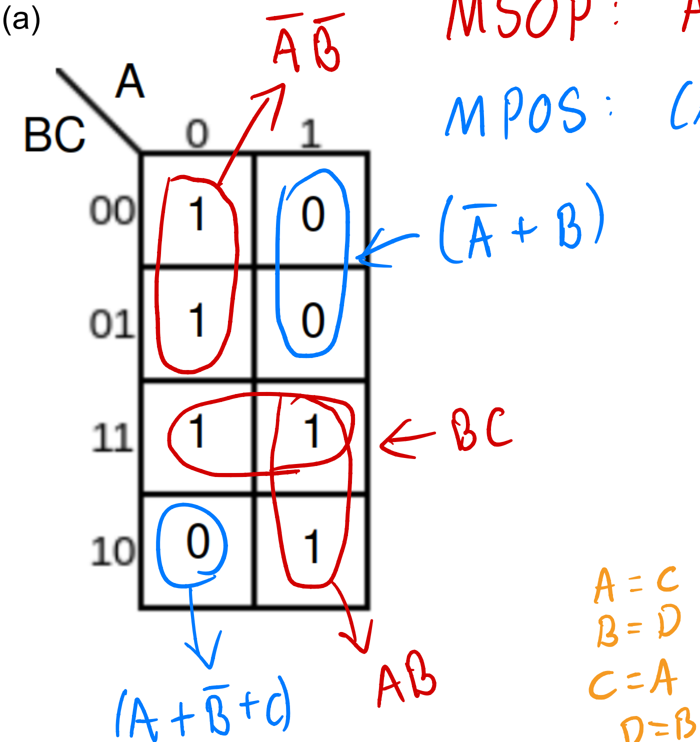
A	B	C	D	output
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

2. Obtain an MSOP and an MPOS for each of the following functions defined by the K-maps:

(a)

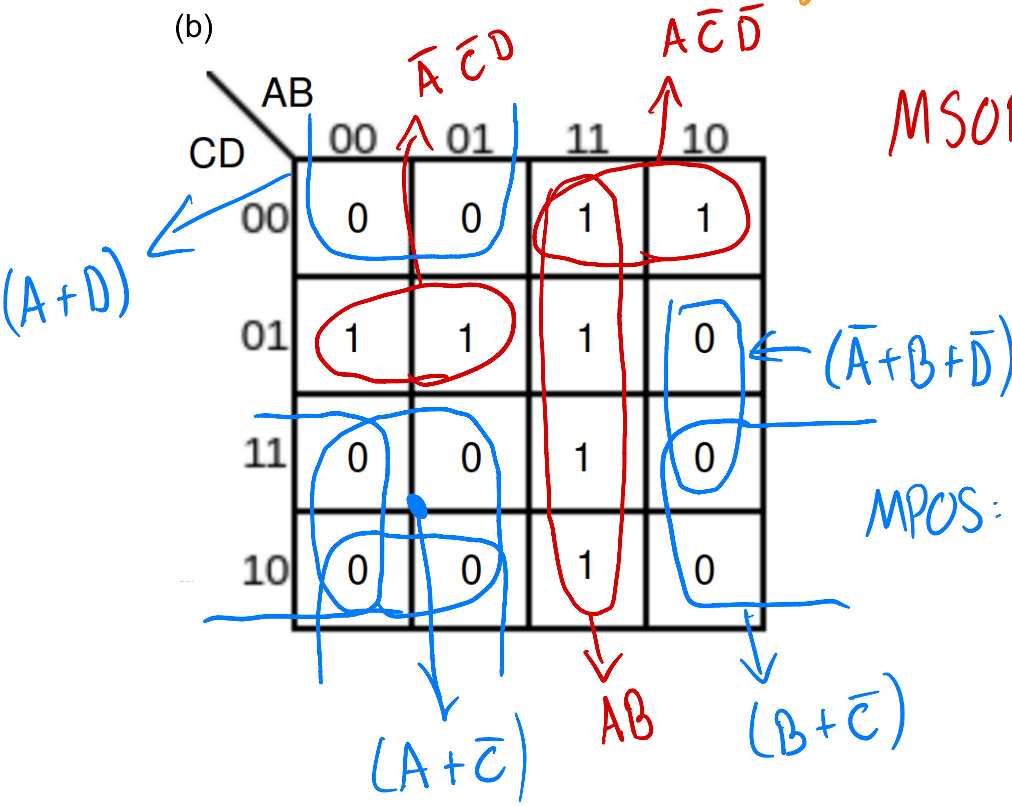
MSOP: $\bar{A}\bar{B} + BC + AB$

MPOS: $(\bar{A}+B)\cdot(A+\bar{B}+C)$



(b)

MSOP: $AB + \bar{A}\bar{C}D + A\bar{C}\bar{D}$



MPOS: $(A+\bar{C})(A+D)(B+\bar{C})(\bar{A}+B+\bar{D})$

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3. *Simplifying K-Maps with Don't Care values:* For each of the following K-maps:

- Find the MSOP expression (show groupings)
- Find the MPOS expression (show groupings)
- Are your solutions unique, or are there other minimum expressions?
- Does the MPOS = MSOP?

(a)

cd \ ab	00	01	11	10
00	X	0	0	1
01	1	0	0	X
11	0	X	0	1
10	0	0	0	1

$A\bar{B}$, $\bar{C}\bar{B}$ } $MSOP = A\bar{B} + \bar{C}\bar{B}$

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

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

$\Rightarrow MSOP = MPOS$

unique, no more non-redundant grouping w/ less literals

(b)

creates non-unique term

cd \ ab	00	01	11	10
00	1	X	0	1
01	1	1	1	0
11	0	0	X	0
10	X	0	1	1

$B\bar{C}D/ABD$, $\bar{A}\bar{C}$, $\bar{B}\bar{D}$, $ABC/AC\bar{D}$ } $MSOP = A\bar{C} + \bar{B}\bar{D} + ABC/AC\bar{D} + B\bar{C}D/ABD$

or any similar answer

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

non-unique, $MPOS \neq MSOP$

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4. Adder design:

(a) Determine the complete truth table for a 2-bit adder (4 inputs A1, A0, B1, B0), and derive equations for both the sum (S1, S0) and the carry (Cout) outputs (no need to simplify).

A + B	A_1	A_0	B_1	B_0	Cout	S_1	S_0	result
0+0	0	0	0	0	0	0	0	0
0+1	0	0	0	1	0	0	1	1
0+2	0	0	1	0	0	1	0	2
0+3	0	0	1	1	0	1	1	3
1+0	0	1	0	0	0	0	1	1
1+1	0	1	0	1	0	1	0	2
1+2	0	1	1	0	0	1	1	3
1+3	0	1	1	1	1	0	0	4
2+0	1	0	0	0	0	1	0	2
2+1	1	0	0	1	0	1	1	3
2+2	1	0	1	0	1	0	0	4
2+3	1	0	1	1	1	0	1	5
3+0	1	1	0	0	0	1	1	3
3+1	1	1	0	1	1	0	0	4
3+2	1	1	1	0	1	0	1	5
3+3	1	1	1	1	1	1	0	6

$$Cout = A_1 A_0 B_1 B_0 + A_1 \bar{A}_0 B_1 \bar{B}_0 + A_1 \bar{A}_0 B_1 B_0 + A_1 A_0 \bar{B}_1 B_0 + A_1 A_0 B_1 B_0$$

$$S_1 = \bar{A}_1 \bar{A}_0 B_1 \bar{B}_0 + \bar{A}_1 \bar{A}_0 B_1 B_0 + \bar{A}_1 A_0 \bar{B}_1 B_0 + \bar{A}_1 A_0 B_1 \bar{B}_0 + A_1 \bar{A}_0 \bar{B}_1 B_0 + A_1 A_0 \bar{B}_1 \bar{B}_0 + A_1 \bar{A}_0 \bar{B}_1 \bar{B}_0 + A_1 A_0 B_1 B_0$$

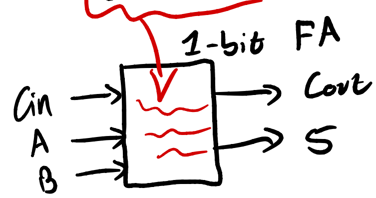
$$S_0 = \bar{A}_1 \bar{A}_0 \bar{B}_1 B_0 + \bar{A}_1 \bar{A}_0 B_1 B_0 + \bar{A}_1 A_0 \bar{B}_1 \bar{B}_0 + A_1 \bar{A}_0 \bar{B}_1 B_0 + A_1 \bar{A}_0 B_1 B_0 + A_1 A_0 \bar{B}_1 \bar{B}_0 + A_1 A_0 B_1 \bar{B}_0$$

(b) Design a 1-bit full adder (3 inputs A, B, Cin) (create a truth table, and show the equations) and use this component to create the equivalent of a 2-bit adder by chaining two components together. The overall circuit you create should have inputs (A1, A0, B1, B0, Cin), and outputs (S1, S0, Cout).

Cin	A	B	Cout	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

$$Cout = AB + C_{in} B + C_{in} A$$

$$S = \bar{C}_{in} \bar{A} B + \bar{C}_{in} A \bar{B} + C_{in} \bar{A} \bar{B} + C_{in} AB$$



2 bit full adder: