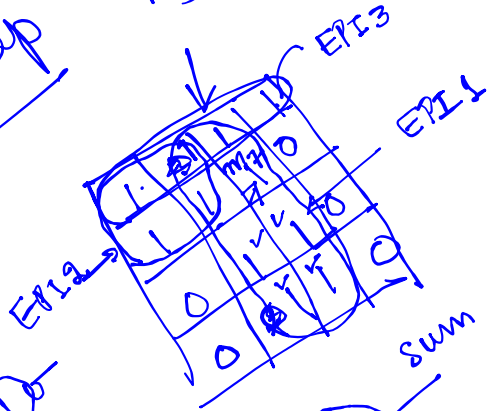


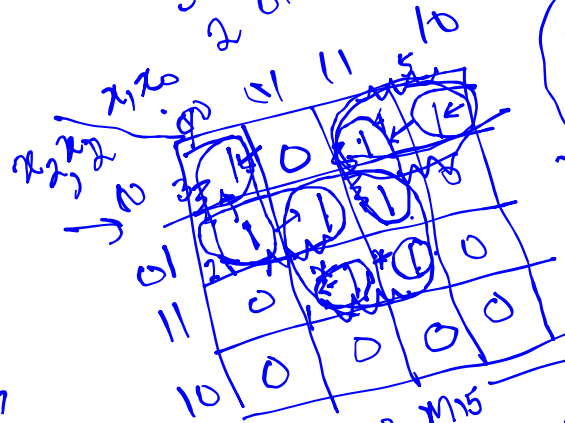
k-map $\overline{x}x = 0$
minimum basic gates



Min. nr. of basic gates

Minimize

3 AND
 2 OR
 $ab + bc + ca$
 $\uparrow \uparrow \uparrow$
 2 input gates



Possible groupings

Prime Implicants

EPI 1

EPI 2

EPI 3

EPI 4

EPI 5

EPI 6

EPI 7

EPI 8

EPI 9

EPI 10

EPI 11

EPI 12

EPI 13

EPI 14

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K-Map (5-Variable) --- An Alternate Style

$$f(A, B, C, D, E) = \sum m(0, 1, 2, 4, 5, 6, 10, 13, 14, 18, 21, 22, 24, 26, 29, 30)$$

Upper Δ

		A = 0			
		D = 1			
BC	DE	00	01	11	10
		m_0	m_1	m_3	m_2
00		1	1	0	1
		m_4	m_5	m_7	m_6
01		1	1	0	1
		m_{12}	m_{13}	m_{15}	m_{14}
11		0	1	0	1
		m_8	m_9	m_{11}	m_{10}
10		0	0	0	1

Lower Δ

		A = 1			
		D = 1			
BC	DE	00	01	11	10
		m_{16}	m_{17}	m_{19}	m_{18}
00		0	0	0	1
		m_{20}	m_{21}	m_{23}	m_{22}
01		0	1	0	1
		m_{28}	m_{29}	m_{31}	m_{30}
11		0	1	0	1
		m_{24}	m_{25}	m_{27}	m_{26}
10		1	0	0	1

*rep. $\bar{A}=1$
rep. $A=1$*

ABC	DE			
	00	01	11	10
100/000	m_0 1 m_{16} 0	m_1 1 m_{17} 0	m_3 0 m_{19} 0	m_2 1 m_{18} 1
101/001	m_4 1 m_{20} 0	m_5 1 m_{21} 1	m_7 0 m_{23} 0	m_6 1 m_{22} 1
111/011	m_{12} 0 m_{28} 0	m_{13} 1 m_{29} 1	m_{15} 0 m_{31} 0	m_{14} 1 m_{30} 1
110/010	m_8 0 m_{24} 1	m_9 0 m_{25} 0	m_{11} 0 m_{27} 0	m_{10} 1 m_{26} 1

$$f(A, B, C, D, E) = \underline{D \cdot \bar{E}} + \underline{C \cdot \bar{D} \cdot E} + \underline{\bar{A} \cdot \bar{B} \cdot \bar{D}} + \underline{A \cdot B \cdot \bar{C} \cdot \bar{E}}$$

K-Map (5-Variable) --- An Alternate Style

Variable included map:

$$f(A, B, C, D, E) = \sum m(0, 1, 2, 4, 5, 6, 10, 13, 14, 18, 21, 22, 24, 26, 29, 30)$$

A=0 f=1 m0-m16 do not upper & lower
A=1 f=0 m17-m30 special combination

A B C \ D E	00	01	11	10
100/000	m ₀ 1 A=0	m ₁ 1	m ₃ 0	m ₂ 1
101/001	m ₄ 1	m ₅ 1	m ₇ 0	m ₆ 1
111/011	m ₁₂ 0	m ₁₃ 1	m ₁₅ 0	m ₁₄ 1
110/010	m ₈ 0	m ₉ 0	m ₁₁ 0	m ₁₀ 1
	m ₂₄ 1	m ₂₅ 0	m ₂₇ 0	m ₂₆ 1

BCDE ⇒ 0000
f = 1 if A=0
f = 0 if A=1
f = A
m₈ & m₂₄ map reduction from a map

map.

B C \ D E	00	01	11	10
00	\bar{A}	\bar{A}	0	1
01	\bar{A}	1	0	1
11	0	1	0	1
10	A	0	0	1

f = value f(0,1)
Variable
D \bar{E} + C \bar{D} E + $\bar{A} \cdot \bar{B} \cdot \bar{D}$ + A · B · C · E

Green: Groups neighbouring 1s

Blue: Groups neighbouring \bar{A} s (including 1s in the neighbourhood).

Red: Groups neighbouring As (including 1s in the neighbourhood).

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

Example for variable included map (from Truth Table):

3 Variables

LSB as variable entry

A	B	C	D	F
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

neigh. 1's
Prime Imp.

neigh. 0's

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

\bar{B}

$\bar{A}\bar{D}$

$\bar{C}D$

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

Min terms

B. algebraic min

torture

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

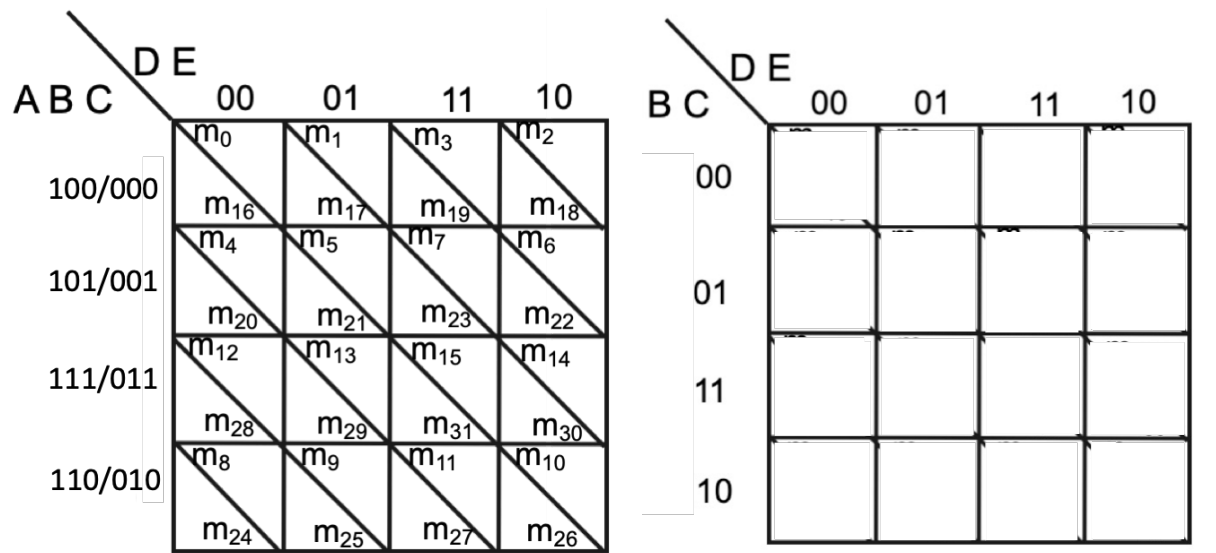
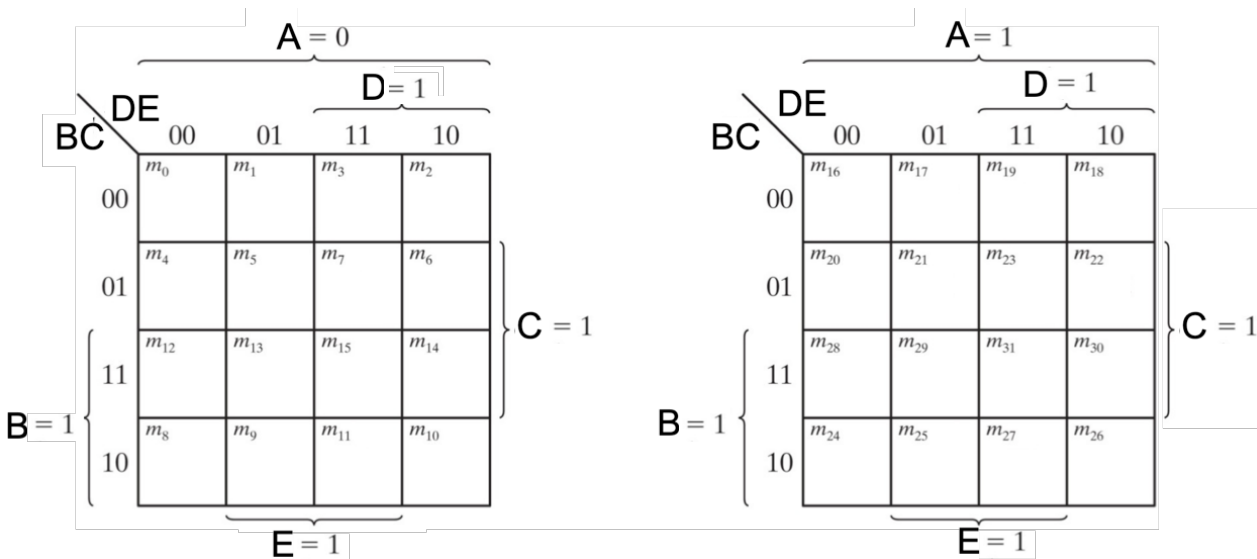
$A\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D}$

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

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

K-Map (5-Variable) --- Home Work

$$\bullet f(A, B, C, D, E) = \sum m(0, 4, 6, 8, 12, 13, 14, 15, 16, 17, 18, 21, 24, 25, 26, 28, 29, 31)$$



K-Map (HW):

- Find minimized SOP
- $f(v, w, x, y, z) = \sum m(0, 4, 8, 10, 11, 12, 13, 15, 17, 19, 26, 27, 28, 29)$
- $f(v, w, x, y, z) = \sum m(1, 3, 5, 7, 8, 10, 12, 13, 14, 19, 22, 24, 28)$
- $f(v, w, x, y, z) = \sum m(0, 1, 2, 7, 8, 9, 11, 12, 14, 15, 16, 17, 24, 27, 30, 31)$
- Consider a circuit which has 4-bit input and 1-bit output. The output of the circuit is high when input has odd number of 1's. Draw the k-map and implement the circuit using only XOR gates.

*If you do not have enough questions
→ New Topic / MUX
Tomorrow we discuss all problems faced in class + all problems faced in HW*

K-Map (Homework)

Design the following with (i) only two input NAND gates, (ii) two input NOR gates

- 4-bit to seven segment display converter.
- Binary to Gray code converter and vice-versa.
- BCD to excess-3 converter and vice-versa.
- 1's complement adder and subtractor.
- 2's complement adder and subtractor.
- Prime number detector for 4-bit input and 5-bit input for unsigned numbers.