

EGC220 Class Notes 2/24/2023

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Test 1:

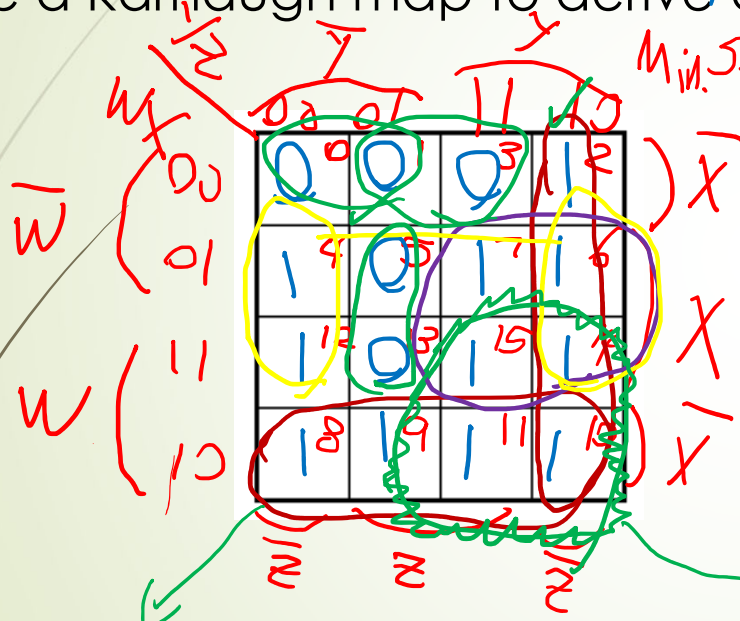
- ▶ Number systems
 - ▶ Convert any base to any base
 - ▶ Quick conversion between base 2, 4, 8, and 16
 - ▶ Add, subtract, multiply in any base
- ▶ Logic gate implementation of a Boolean function
- ▶ Boolean properties and laws
- ▶ Simplification of Boolean algebra using Boolean laws
- ▶ Representing Boolean functions in terms of
 - ▶ Sum of min-terms, product of max-terms, standard sum of products, standard product of sums, minimum sum of products, minimum product of sums
 - ▶ Representing Boolean functions using all NAND or NOR gates.
- ▶ Simplification using K-map (up to 5 variables)
 - ▶ SOP, POS, Standard SOP and POS, Min. SOP and POS
- ▶ Design of combinational circuits

1. Given $X = F(w, x, y, z) = \prod M(0, 1, 3, 5, 13)$

- a. Write the complete truth table for $Y = f(w, x, y, z)$.
- b. Write $Y = f(w, x, y, z)$ in standard POS form and standard SOP form.
- c. Write $Y = f(w, x, y, z)$ in sum of min-terms and product of max terms.

$= \sum m(2, 4, 6, 7, 8, 9, 10, 11, 12, 14, 15)$

Use a Karnaugh map to derive a minimized POS and minimized SOP.



Min. S.O.P. $F = \underline{y\bar{z}} + \underline{w\bar{x}} + \underline{xy} + \underline{x\bar{z}} \checkmark$

$\bar{F} = \underline{x\bar{y}z} + \underline{\bar{w}y\bar{x}} + \underline{\bar{w}\bar{x}y} + \underline{\bar{w}x\bar{z}}$

Min. P.O.S. $F = (\underline{\bar{x} + y + \bar{z}})(\underline{w + x + y})(\underline{w + x + \bar{z}})$

Non-essential

essential

1. Given $Y = f(w, x, y, z) = \prod M(0, 1, 3, 5, 13)$,

1. Write the complete truth table for $Y = f(w, x, y, z)$.

2. Write $Y = f(w, x, y, z)$ in standard POS form and standard SOP form.

3. Write $Y = f(w, x, y, z)$ in sum of min-terms and product of max terms.

Handwritten truth table for $Y = f(w, x, y, z)$ with annotations:

	\bar{z}	z		
	\bar{y}	y	\bar{y}	y
	\bar{x}	x	\bar{x}	x
\bar{w}	00	01	11	10
w	11	10	01	00
	0	1	2	3
	4	5	6	7
	8	9	10	11
	12	13	14	15
	16	17	18	19
	\bar{z}	z	\bar{z}	z

Annotations: Red circles around 0, 1, 3, 5, 13. Blue circles around 4, 6, 12, 14. Purple circles around 1, 5, 9, 13. Green circles around 0, 4, 8, 12. Red arrows pointing to \bar{x} , x , \bar{x} , x on the right side.

Handwritten Karnaugh map for $Y = f(w, x, y, z)$ with annotations:

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Annotations: Blue circles around 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. Red dashed lines indicating groupings.

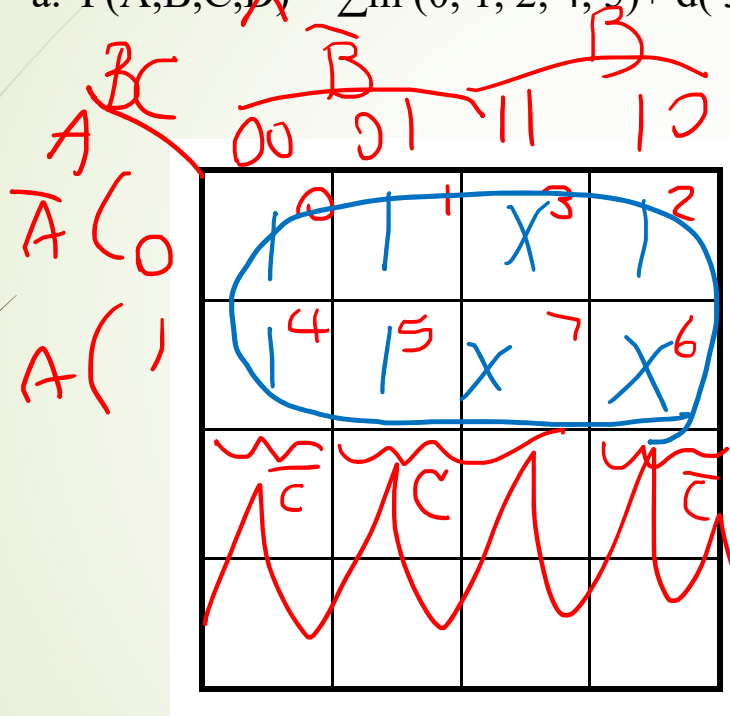
$$F = w\bar{x} + xy + x\bar{z} + y\bar{z}$$

$$F = \bar{x}\bar{y}\bar{z} + \bar{w}\bar{x}\bar{y} + \bar{w}\bar{x}z$$

$$F = (\bar{x} + y + \bar{z})(w + \bar{x} + x)(w + \bar{x} + \bar{z})$$

2. Simplify the following Boolean functions using four variables K-maps and express your answer in minimum sum of products and minimum product of sums.

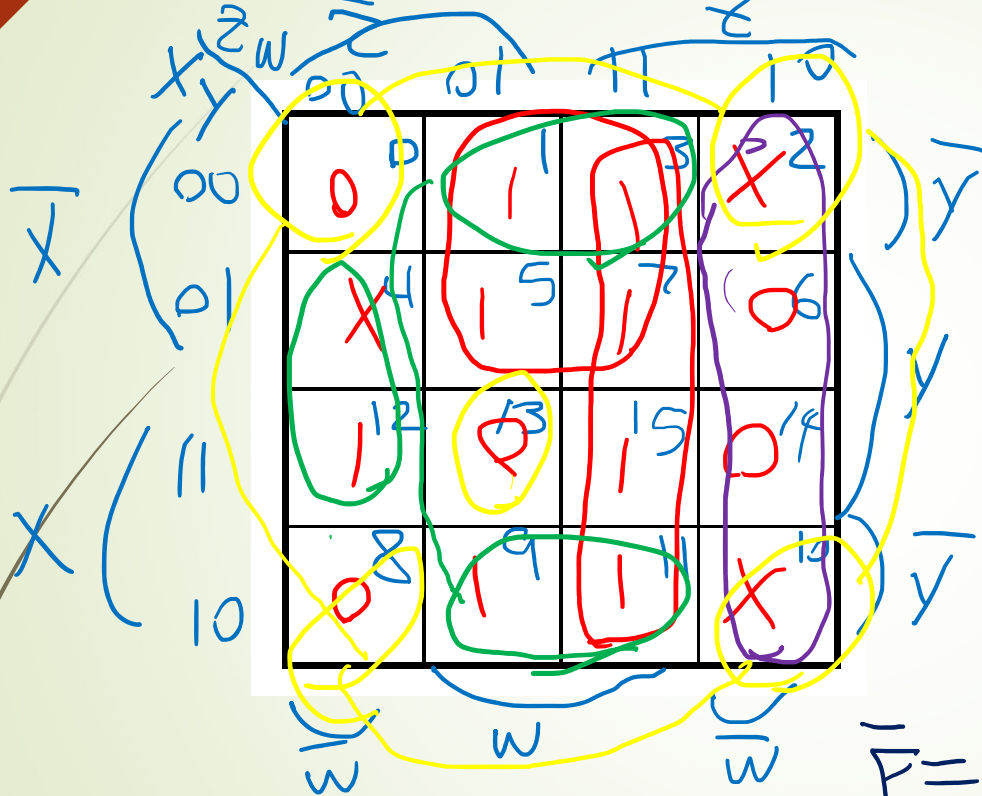
a. $F(A,B,C,D) = \sum m(0, 1, 2, 4, 5) + d(3, 6, 7)$



Min SOP
 $F = 1$

Min P.O.S
 $\overline{F} = 0$
 $F = 1$

b. $F(X, Y, Z, W) = \prod M(0, 6, 8, 13, 14) + d(2, 4, 10)$



Product of Max terms
 * Sum of min terms
 $F = \sum M(1, 3, 5, 7, 9, 11, 12, 15) + d(2, 4, 10)$

Min S.O.P
 $F = \underline{z}w + \bar{x}\underline{w} + \bar{y}\underline{w} + \underline{y}\bar{z}\bar{w}$

Min. P.O.S

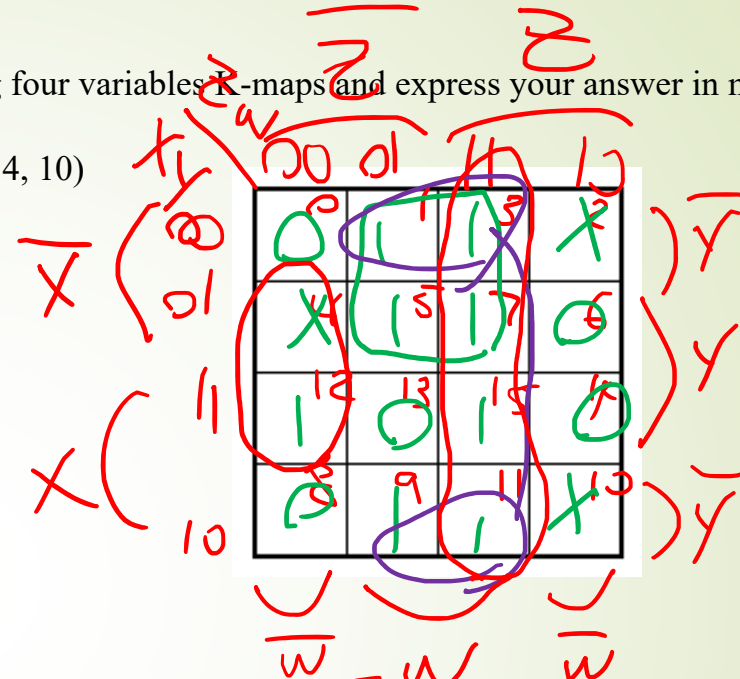
$$\bar{F} = z\bar{w} + \bar{y}\bar{w} + xy\bar{z}w$$

$$F = (\bar{z} + w)(y + w)(\bar{x} + \bar{y} + z + \bar{w})$$

2. Simplify the following Boolean functions using four variables K-maps and express your answer in minimum sum of products and minimum product of sums.

b. $F(X, Y, Z, W) = \prod M(0, 6, 8, 13, 14) + d(2, 4, 10)$

$$F = \bar{Y}W + ZW + XW + Y\bar{Z}\bar{W}$$

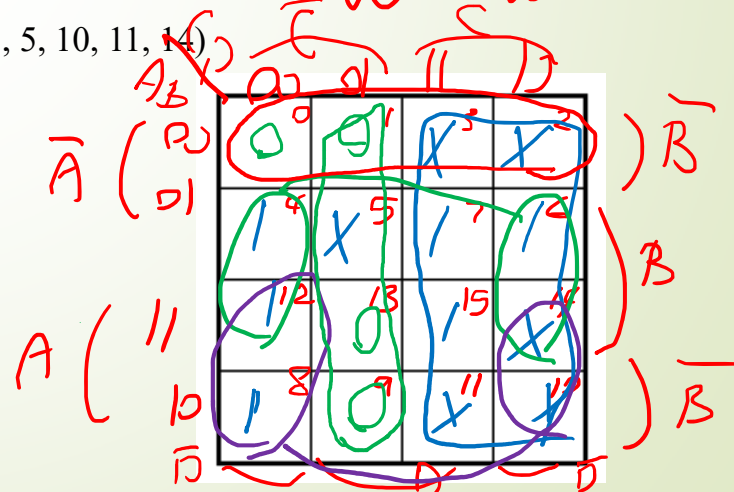


c. $F(A, B, C, D) = \sum m(4, 6, 7, 8, 12, 15) + d(2, 3, 5, 10, 11, 14)$

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

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

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



3. For $F(A,B,C,D,E) = A'B'C + A'CE + A'BE + ABE + A'B'CD$ (Note: $A' = \bar{A}$) determine

f. Minimum sum of products.

g. Minimum products of sums.

h.

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

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

	0	1	3	2
1	4	5	7	6
12	15	15	14	
8	9	11	10	

\bar{D} D
 \bar{B} \bar{C} C
 B \bar{C} C

	16	17	19	18
20	21	23	22	
28	29	31	30	
24	25	27	26	



3. For $F(A,B,C,D,E) = A'B'C + A'CE + A'BE + ABE + A'B'CD$ (Note: $A' = \bar{A}$) determine

f. Minimum sum of products.

g. Minimum products of sums.

h.

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

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

	\bar{D}	D	
\bar{B}	16	17	19
B	16	17	19
\bar{C}	16	17	19
C	16	17	19
\bar{E}	16	17	19
E	16	17	19

$$\bar{F} = AB + \bar{B}\bar{C} + B\bar{E} \rightarrow F = (\bar{A} + B)(B + C)(\bar{B} + E)$$

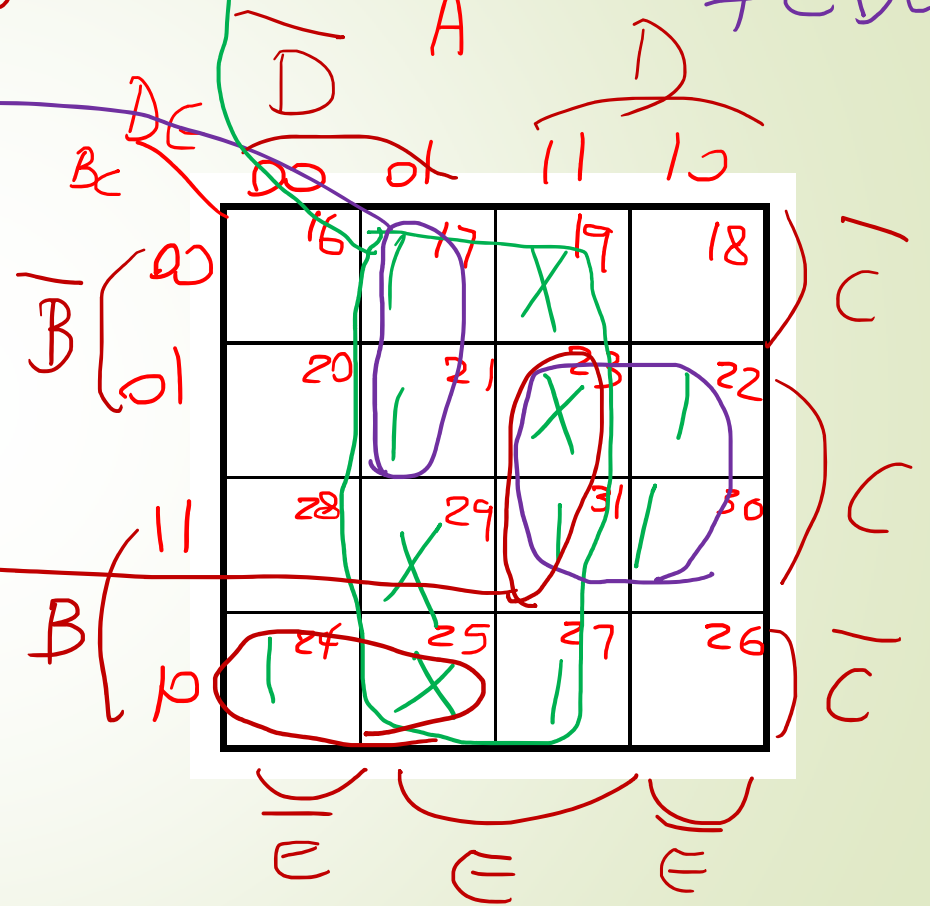
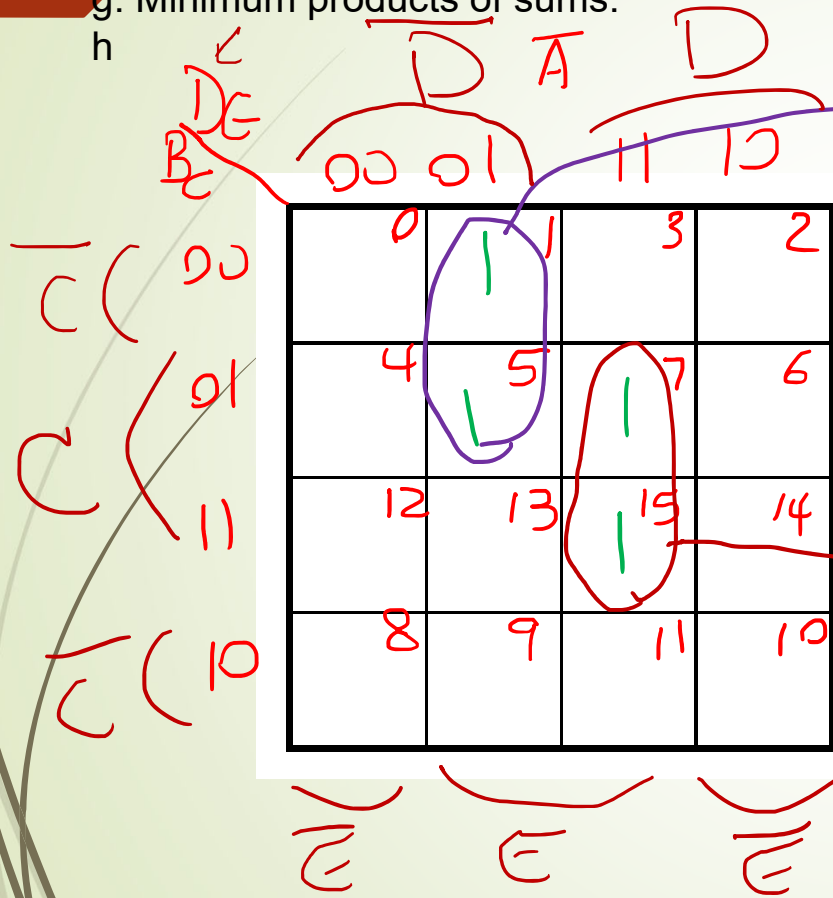
3. For $F(A,B,C,D,E) =$ (Note: $A' = \bar{A}$) determine

f. Minimum sum of products.

g. Minimum products of sums.

h.

$$F = AE + ACD + \bar{B}\bar{D}E + CDE + A\bar{B}\bar{C}\bar{D}$$



Min. S.O.P \rightarrow NAND

$$F = A\bar{B}C + ACD + BD$$

Min. P.O.S \rightarrow NOR

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

