

Digital Logic Design

Lecture 4

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Karnaugh Maps

Karnagh Maps

- Signed Numbers
- XOR

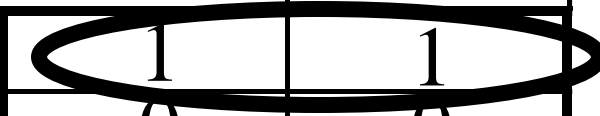
Karnaugh Maps

Karnaugh Map Method: A visual method for identifying adjacency groups of 1's or 0's.

Karnaugh Map: A grid used to store truth table data in an efficient form.

A	B	F
0	0	1
0	1	0
1	0	1
1	1	0

A		\overline{A}	A
B	\overline{B}	0	1
	B	1	1
		0	1
	B	1	0
		0	0



$F = \overline{B}$

Karnaugh Maps

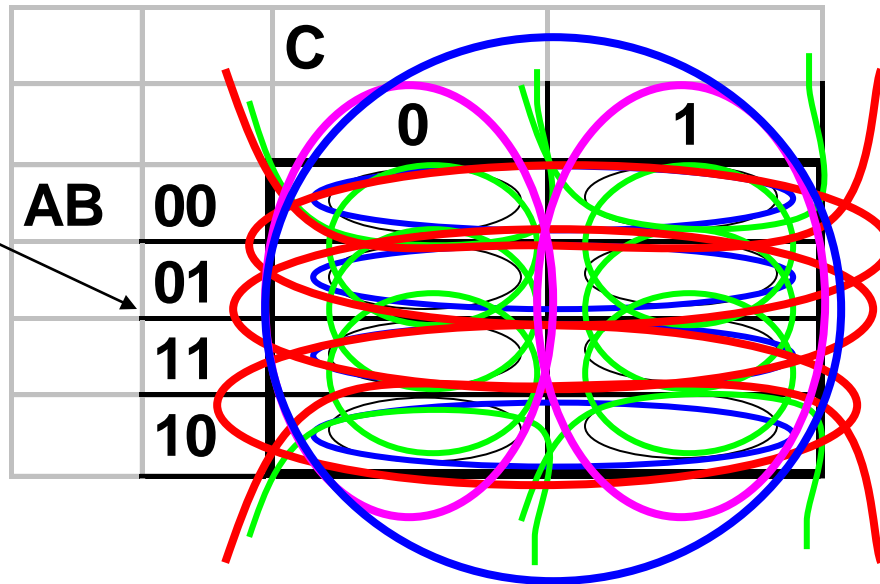
- Adjacency groups that are valid must have 2^k elements. (1, 2, 4, 8, 16 etc.)
- Some groups with 2, 4, etc elements are NOT adjacency groupings. **Example**

	B	\overline{B}	B
A		0	1
\overline{A}	0		
A	1		

Karnaugh Maps

Q? How many Boolean Cubes on a 3 variable Karnaugh Map?

Note the ordering on AB axis.



A: Many.

Karnaugh Maps

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

		C	
		0	1
AB	00	0	1
	01	0	1
	11	1	1
	10	1	1

$F = A + C$

What is PI and EPI

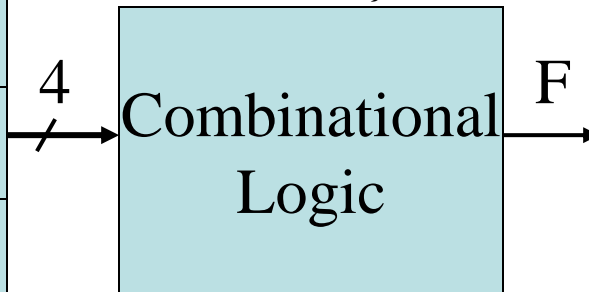
Karnaugh Maps

- Don't Cares: Values assigned to a function for input combinations that can't occur.

Decimal Keypad

1	2	3
4	5	6
7	8	9
	0	

$F = \{1 \text{ if key is multiple of 3, } 0 \text{ otherwise}\}$



	AB		F	
CD	00	01	11	10
00	1	0	X	0
01	0	0	X	1
11	1	0	X	X
10	0	1	X	X

Key	Key Pad Output (ABCD)	F
0	0000	1
1	0001	0
2	0010	0
3	0011	1
4	0100	0
5	0101	0
6	0110	1
7	0111	0
8	1000	0
9	1001	1
-	1010	X
-	1011	X
-	1100	X
-	1101	X
-	1110	X
-	1111	X

Karnaugh Maps

- Find the Min SOP for the following 4-variable function:

Handwritten notes on the left: $ABCD \rightarrow$ (with 0s below each letter), $F(A,B,C,D)$, and $F(w,x,y,z)$.

CD \ AB	00	01	11	10
00	X ⁰	1 ¹	0 ³	1 ²
01	0 ⁴	1 ⁵	1 ⁷	1 ⁶
11	0 ¹²	X ¹³	X ¹⁵	0 ¹⁴
10	0 ⁸	1 ⁹	0 ¹¹	1 ¹⁰

Handwritten groupings and labels on the right: BD (grouping cells 1, 5, 9, 13), $\bar{B}C\bar{D}$ (grouping cells 1, 5, 13, 15), $\bar{A}C\bar{D}$ (grouping cells 13, 15), and $\bar{C}D$ (grouping cells 1, 5, 9, 13).

Don't Cares (X) may be grouped as 1's or 0's but not both.

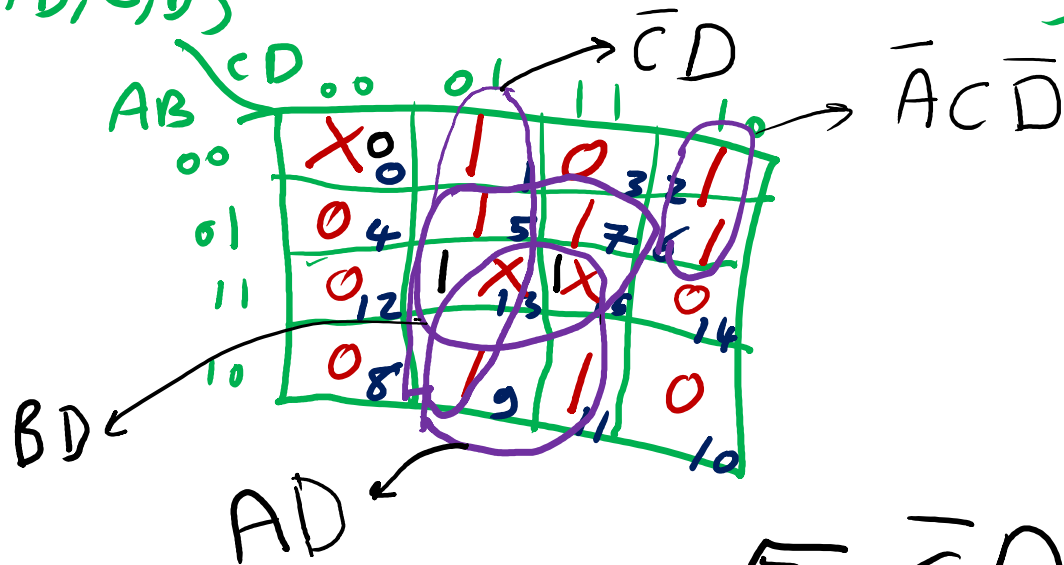
$$F = \sum m(1,2,5,6,7,9,10,13,15)$$

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

$$F = \sum m(1, 2, 5, 6, 7, 9, 11)$$

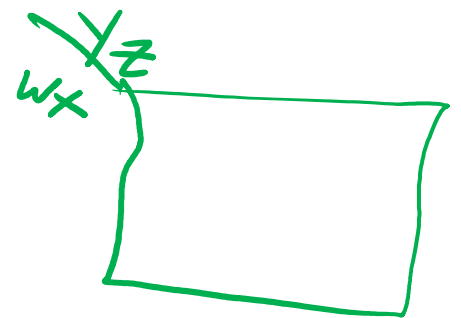
don't care $\sum m(0, 13, 15)$

$F(A, B, C, D)$



$$F = \bar{C}D$$

$$F(w, x, y, z)$$



Karnaugh Maps

What is PI and EPI

Karnaugh Maps

- **Using Karnaugh Maps to minimize functions by grouping 1's gave a Min SOP Form:**
- **Using Karnaugh Maps to minimize functions by grouping 0's gives a Min POS Form:**

Karnaugh Maps

- Find the Min POS for the following 3-variable function:

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	X
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

		C	
		0	1
AB	00	0	1
	01	X	1
	11	1	0*
	10	0	0

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