



BITS Pilani

Hyderabad Campus

Department of Electrical Engineering



Digital Design

First Semester 2020-21

Tutorial : 03

K-Maps

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- 1, Plot the Boolean express $X = AB + A\overline{B} + BC$ and minimize expression from the Map.

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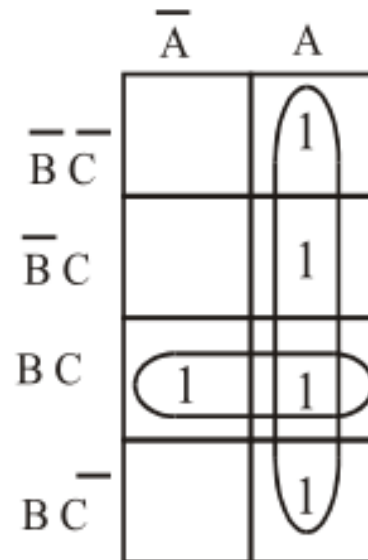
- 1, **Plot the Boolean express $X = AB + A\overline{B} + BC$ and minimize expression from the Map.**

Since the expression contains three variables, we need a Karnaugh map containing cells equal to

$$N = 2^3 = 8$$

$$X = A + BC$$

	\overline{A}	A
$\overline{B}\overline{C}$		1
$\overline{B}C$		1
BC	1	1
$B\overline{C}$		1



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2. Minimize using K-map

$$F(A, B, C) = \sum m(0, 1, 4, 5) = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C$$

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2. Minimize using K-map

$$F(A, B, C) = \sum m(0, 1, 4, 5) = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C$$

- Solution:

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

zero-set(2, 3, 6, 7)

one-set(0, 1, 4, 5)

- The essential prime implicants are \bar{B} .
- There are no non-essential prime implicants.
- The sum-of-products solution is $F = \bar{B}$.

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3. Minimize using K-map

$$F(A, B, C) = \sum m(0, 1, 4, 5) = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C$$

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3. Minimize using K-map

$$F(A, B, C) = \sum m(0, 1, 4, 6, 7) = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + A\bar{B}\bar{C} + AB\bar{C} + ABC$$

- Solution:

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

zero-set(2, 3, 5)

one-set(0, 1, 4, 6, 7)

- The essential prime implicants are $\bar{A}\bar{B}$ and AB .
- The non-essential prime implicants are $\bar{B}\bar{C}$ or $A\bar{C}$.
- The sum-of-products solution is

$$F = AB + \bar{A}\bar{B} + \bar{B}\bar{C} \text{ or } F = AB + \bar{A}\bar{B} + A\bar{C}.$$

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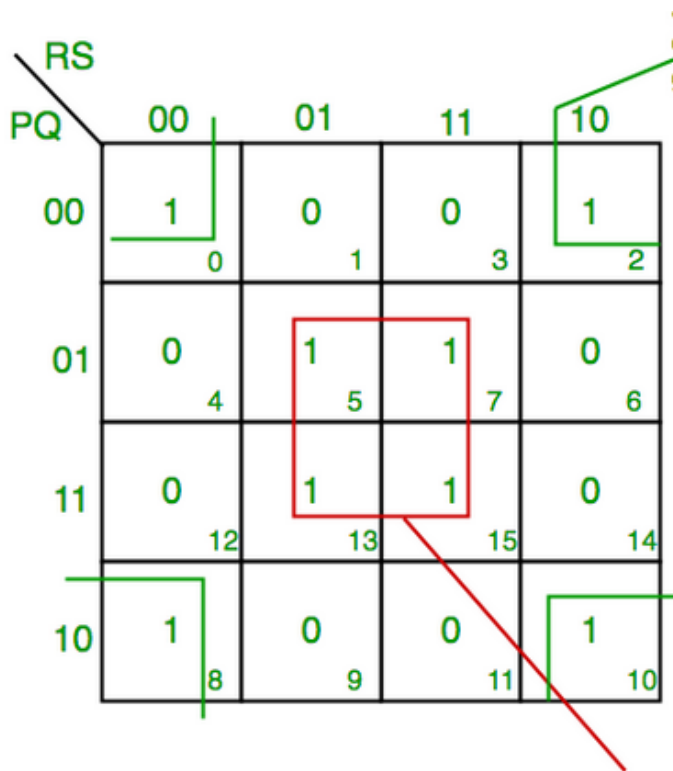
4. Minimize using K-map

$$F(P,Q,R,S) = \sum(0,2,5,7,8,10,13,15)$$

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4. Minimize using K-map

$$F(P,Q,R,S) = \sum(0,2,5,7,8,10,13,15)$$



- Final expression ($QS + Q'S'$)

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5. Minimize using K-map $F(A,B,C,D) = \prod M(0, 1, 5, 7, 8, 9, 15)$

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5. Minimize using K-map $F=(A,B,C,D) = \prod M(0, 1, 5, 7, 8, 9, 15)$

• Solution:

- The essential prime implicants are $\mathbf{B + C}$ and $\mathbf{\bar{B} + \bar{C} + \bar{D}}$.

zero-set(0, 1, 5, 7, 8, 9, 15)

one-set(2, 3, 4, 6, 10, 11, 12, 13, 14)

- The non-essential prime implicants can be $\mathbf{A + \bar{B} + \bar{D}}$ or $\mathbf{A + C + \bar{D}}$.
- The product-of-sums solution can be either

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

or

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

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

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6. Minimize using K-map (dc stands for Don't Care Condition)

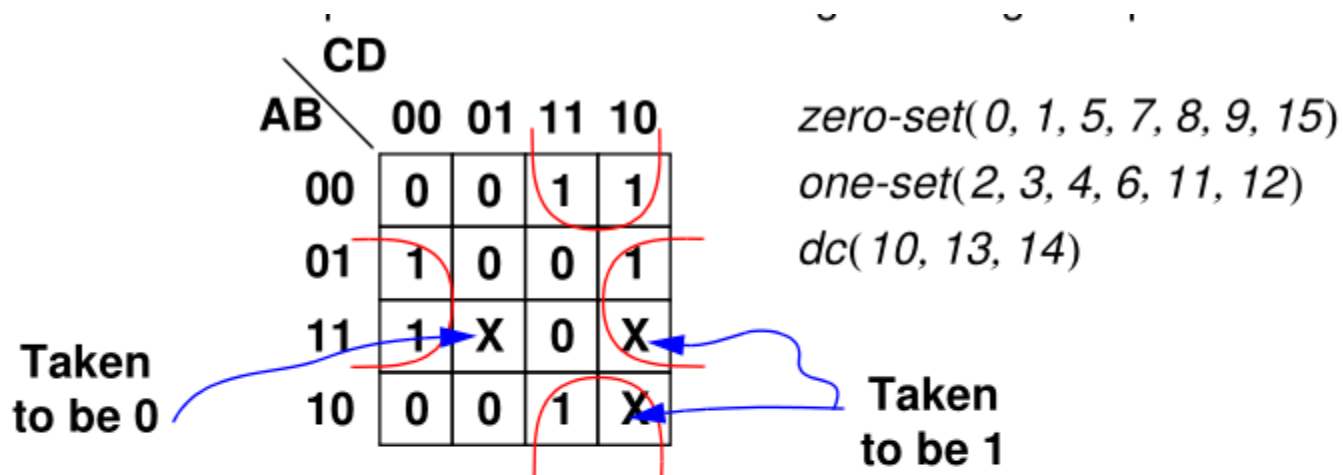
zero-set(0, 1, 5, 7, 8, 9, 15)

one-set(2, 3, 4, 6, 11, 12)

dc(10, 13, 14)

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6. Minimize using K-map (dc stands for Don't Care Condition)



- Solution:
 - The essential prime implicants are $\mathbf{B\bar{D}}$ and $\mathbf{\bar{B}C}$.
 - There are no non-essential prime implicants.
 - The sum-of-products solution is $\mathbf{F = \bar{B}C + B\bar{D}}$.

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7. Find the POS simplification for the following Karnaugh map
(dc stands for Don't Care Condition)

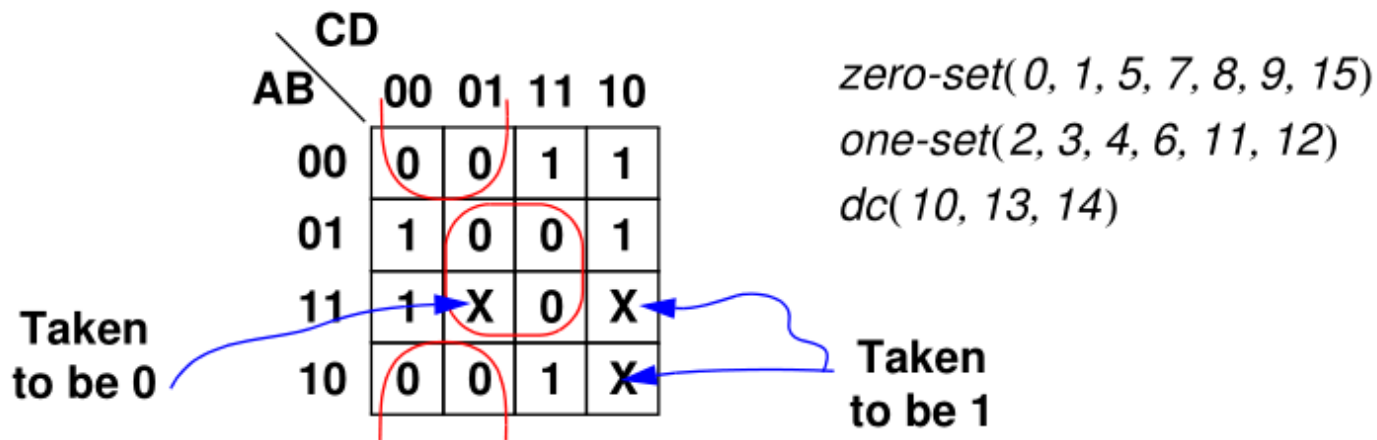
zero-set(0, 1, 5, 7, 8, 9, 15)

one-set(2, 3, 4, 6, 11, 12)

dc(10, 13, 14)

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7. Find the POS simplification for the following Karnaugh map (dc stands for Don't Care Condition)



• Solution:

- The essential prime implicants are $B + C$ and $\bar{B} + \bar{D}$.
- There are no non-essential prime implicants.
- The product-of-sums solution is $F = (B + C)(\bar{B} + \bar{D})$.

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8.

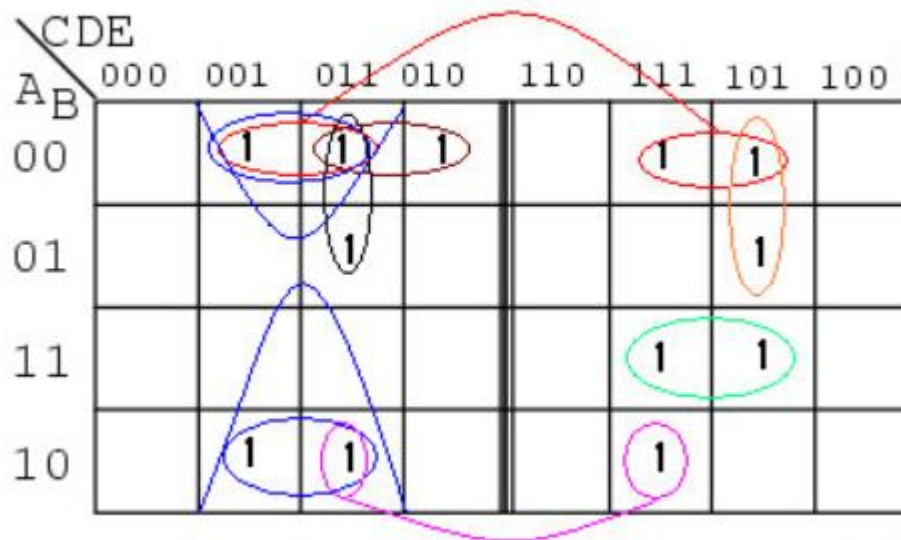
Design a circuit which has a 5-bit binary input (A, B, C, D, E), with A being the MSB (Most Significant Bit). It must produce an output logic High for any prime number detected in the input data.

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8.

The minterm associated for detection of prime numbers in the five variable inputs are $m_1, m_2, m_3, m_5, m_7, m_{11}, m_{13}, m_{17}, m_{19}, m_{23}, m_{29}$ and m_{31} . The corresponding 5 variable



$$Y = A'B'E + B'C'E + A'B'C'D + AB'DE + A'CD'E + ABCE + A'C'DE$$