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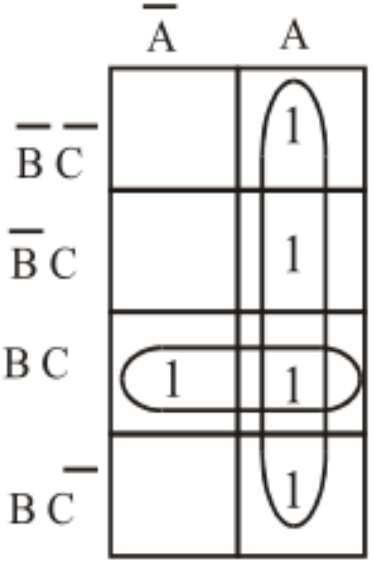
1, **Plot the Boolean express $X = AB + A\overline{B} + BC$ and minimize expression from the Map.**

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

$N = 2^3 = 8$



$$X = A + BC$$

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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:

A \ BC	00	01	11	10
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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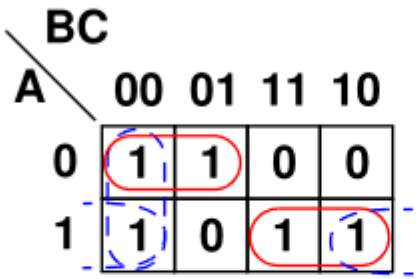
3. Minimize using K-map

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

- Solution:



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

$F = AB + \bar{A}\bar{B} + \bar{B}\bar{C}$ 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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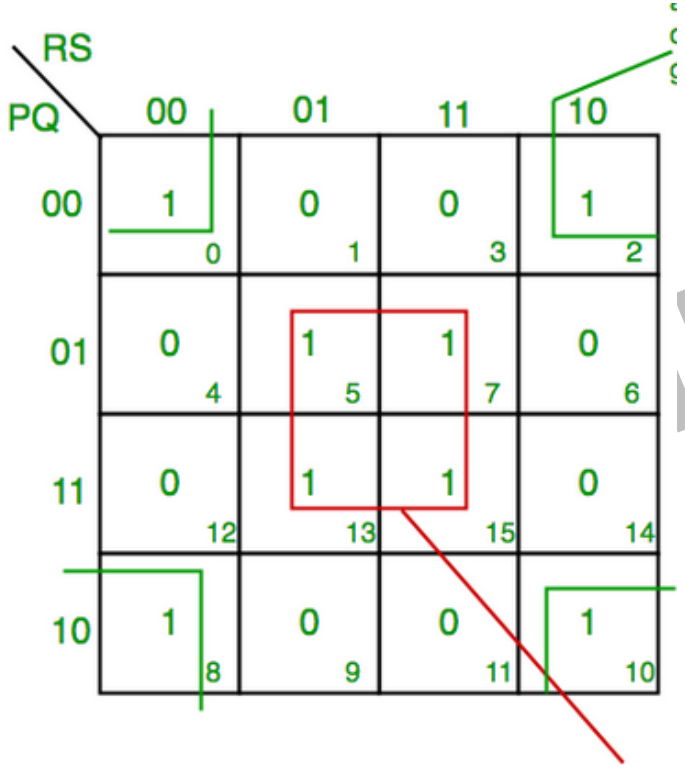
4. Minimize using K-map

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



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

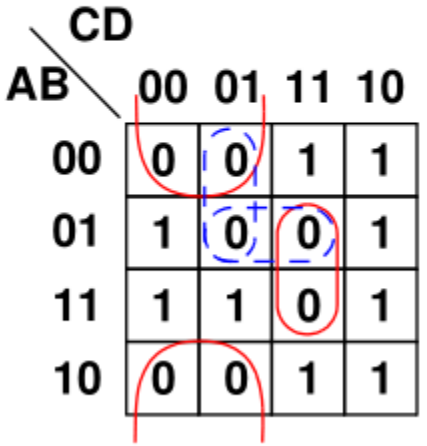
    $\mathbf{F} = (\mathbf{B} + \mathbf{C})(\bar{\mathbf{B}} + \bar{\mathbf{C}} + \bar{\mathbf{D}})(\mathbf{A} + \bar{\mathbf{B}} + \bar{\mathbf{D}})$

    or

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

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

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



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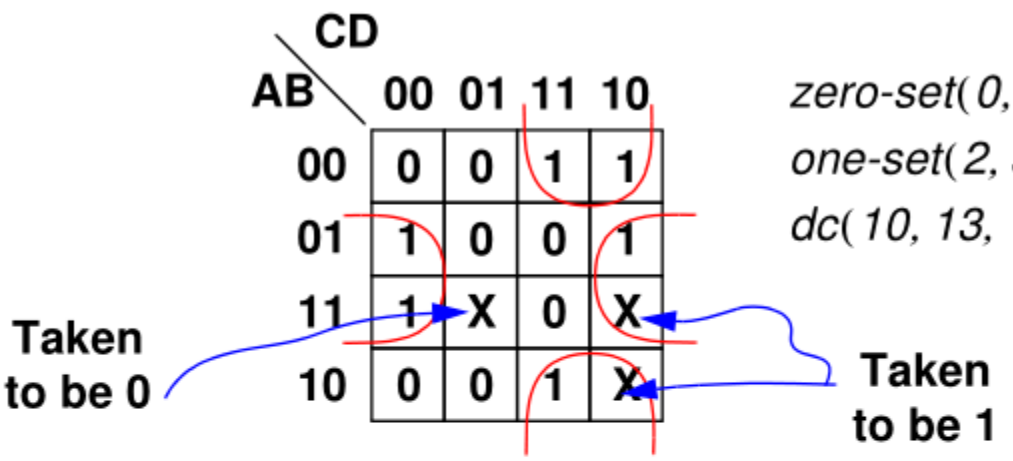
6. Minimize using K-map (dc stands for Don't Care Condition)



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

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

dc(10, 13, 14)

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

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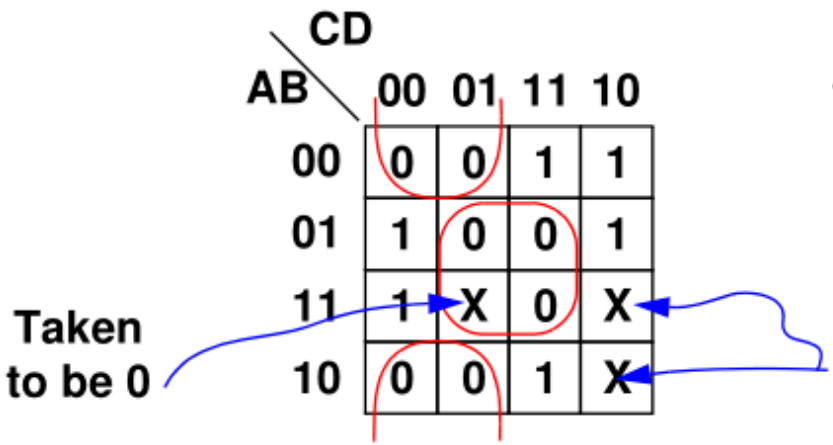
7. Find the POS simplification for the following Karnaugh map (dc stands for Don't Care Condition)



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

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

dc(10, 13, 14)

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

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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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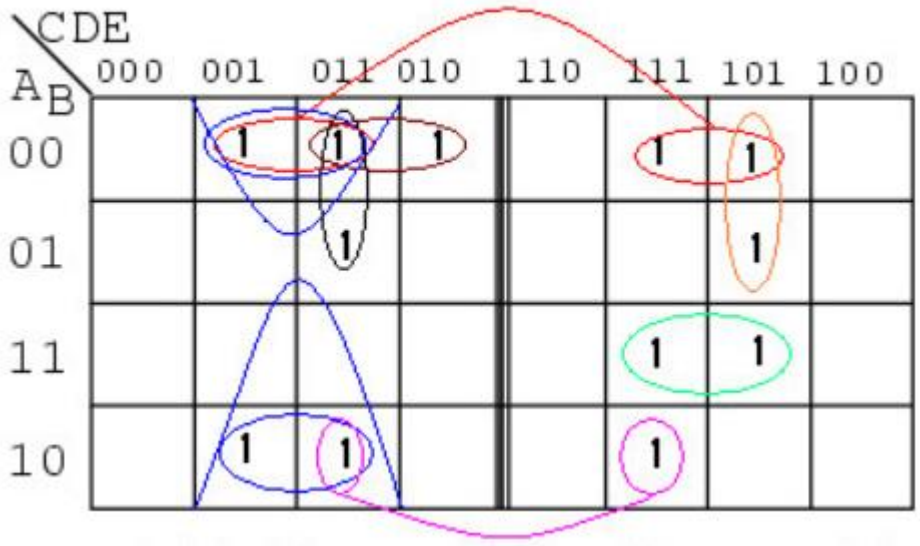
8.

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