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CSCI 150
Introduction to Digital and Computer System Design
Assignment 2

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2020 Winter Semester (S1)

Overview

- Focus: Boolean Algebra, Basic Logic Circuits
- Architecture: Combinatory Logic Circuits
- Textbook v4: Ch2; v5: Ch2
- Core Ideas:

1. Assignment 2
2. Prepare for Quiz 2

P1
Prove!

Prove The Following Boolean Equations

A. Truth Table: $\overline{ABCD} = \overline{A} + \overline{B} + \overline{C} + \overline{D}$

A	B	C	D	$\overline{A} + \overline{B} + \overline{C} + \overline{D}$	$\overline{ABCD}$
0	0	0	0	1	1
0	0	0	1	1	1
0	0	1	0	1	1
0	0	1	1	1	1
0	1	0	0	1	1
0	1	0	1	1	1
0	1	1	0	1	1
0	1	1	1	1	1

A	B	C	D	$\overline{A} + \overline{B} + \overline{C} + \overline{D}$	$\overline{ABCD}$
1	0	0	0	1	1
1	0	0	1	1	1
1	0	1	0	1	1
1	0	1	1	1	1
1	1	0	0	1	1
1	1	0	1	1	1
1	1	1	0	1	1
1	1	1	1	0	0

Solution

P1
Prove!

Prove The Following Boolean Equations

A. Truth Table: $\overline{ABCD} = \overline{A} + \overline{B} + \overline{C} + \overline{D}$

A	B	C	D	$\overline{A} + \overline{B} + \overline{C} + \overline{D}$	$\overline{ABCD}$
X	X	X	0	1	1
X	X	0	X	1	1
X	0	X	X	1	1
0	X	X	X	1	1
1	1	1	1	0	0

Solution

P1
Prove!

Prove The Following Boolean Equations

B. Algebraic Manipulation: $A(\overline{A}+B)(\overline{AB}+C)(\overline{ABC}+D)=ABCD$

$$=AB(\overline{AB}+C)(\overline{ABC}+D) \quad \textbf{Rule F}$$

$$=ABC(\overline{ABC}+D) \quad \textbf{Rule F}$$

$$=ABCD \quad \textbf{Rule F}$$

Solution

P1
Prove!

Prove The Following Boolean Equations

C. Algebraic Manipulation: $\overline{X}Y + \overline{Y}Z + X\overline{Z} = X\overline{Y} + Y\overline{Z} + \overline{X}Z$

$$= (\overline{X}YZ + \overline{X}Y\overline{Z}) + (X\overline{Y}Z + \overline{X}\overline{Y}Z) + (XY\overline{Z} + X\overline{Y}\overline{Z}) \quad \textbf{Rule B}$$

$$= (X\overline{Y}Z + X\overline{Y}\overline{Z}) + (\overline{X}Y\overline{Z} + XY\overline{Z}) + (\overline{X}YZ + \overline{X}\overline{Y}Z) \quad \textbf{Rule 10}$$

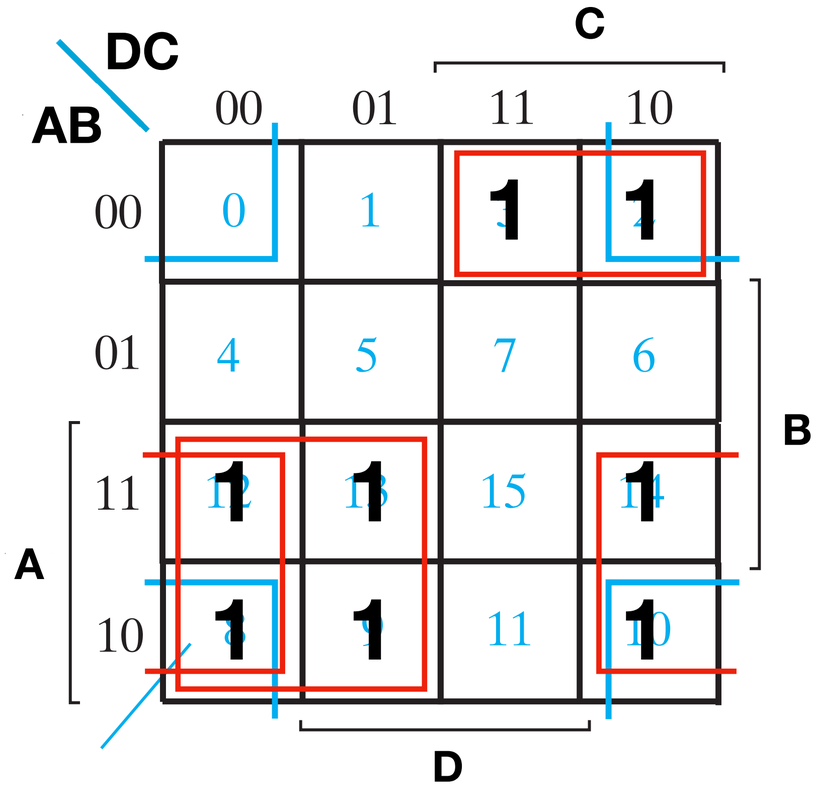
$$= X\overline{Y} + Y\overline{Z} + \overline{X}Z \quad \textbf{Rule B}$$

Solution

P2
K-Map

Optimise The Following Boolean Functions using K-map

A. $F(A,B,C,D) = \Sigma m(2,3,8,9,10,12,13,14)$



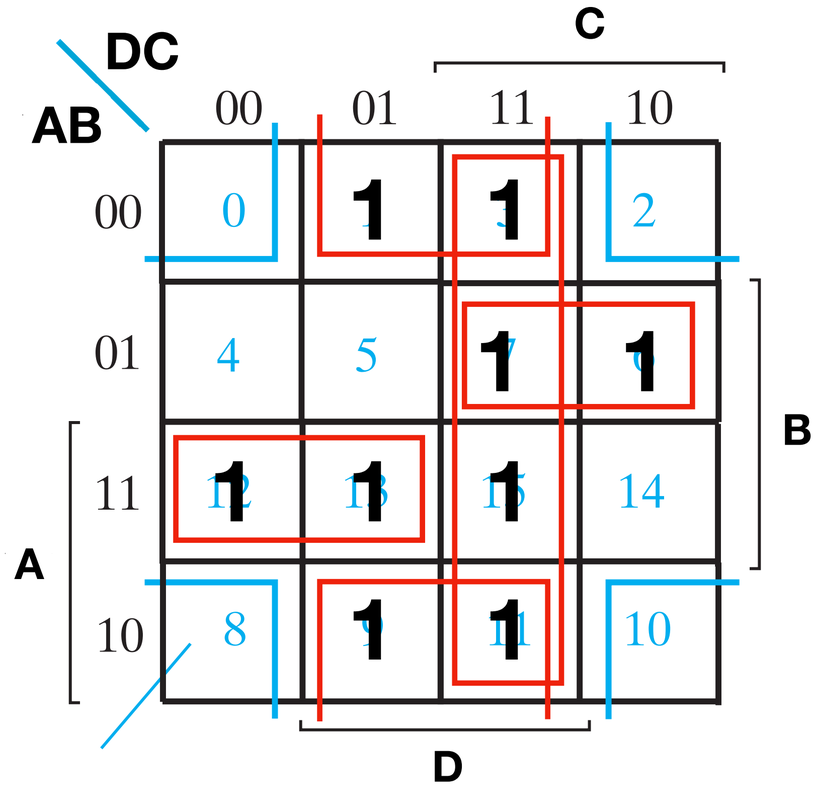
$$A\overline{C} + \overline{A}\,\overline{B}C + A\overline{D}$$

Solution

P2
K-Map

Optimise The Following Boolean Functions using K-map

B. $F(A,B,C,D) = \Sigma m(1,3,6,7,9,11,12,13,15)$



$$CD + BD + \overline{A}BC + AB\overline{C}$$

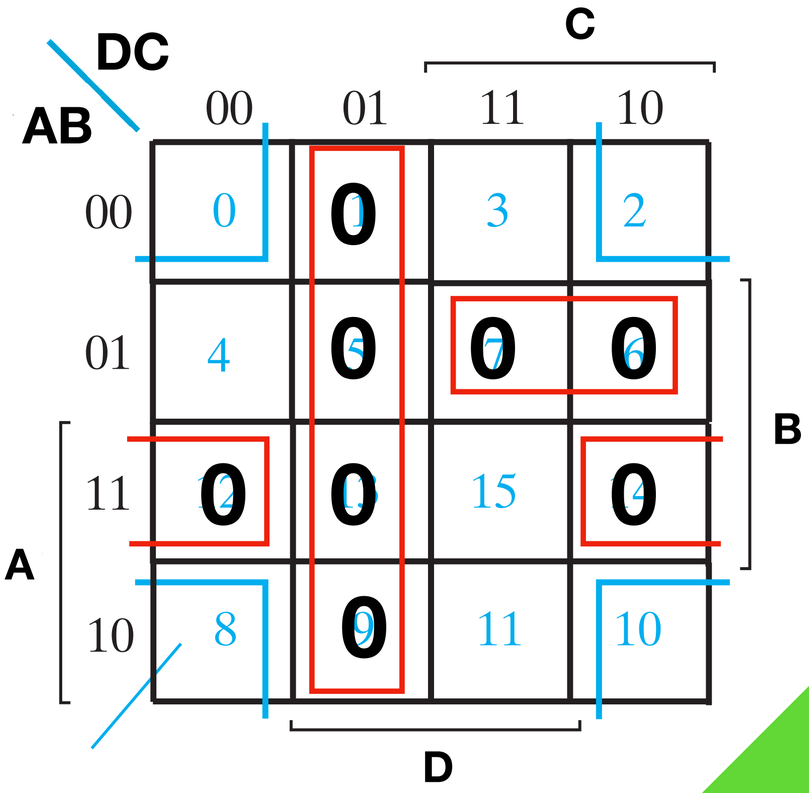
Solution

P3
Product of Sums

Optimise The Following Boolean Expressions in Product-of-Sums Form

A. $F(A,B,C,D) = \Sigma m(0,2,3,4,8,10,11,15)$

- $F(A,B,C,D) = \overline{\Sigma m(1,5,6,7,9,12,13,14)}$
$= \overline{\overline{C}D + AB\overline{D} + \overline{A}BC}$
$= (C + \overline{D})(\overline{A} + \overline{B} + D)(A + \overline{B} + \overline{C})$



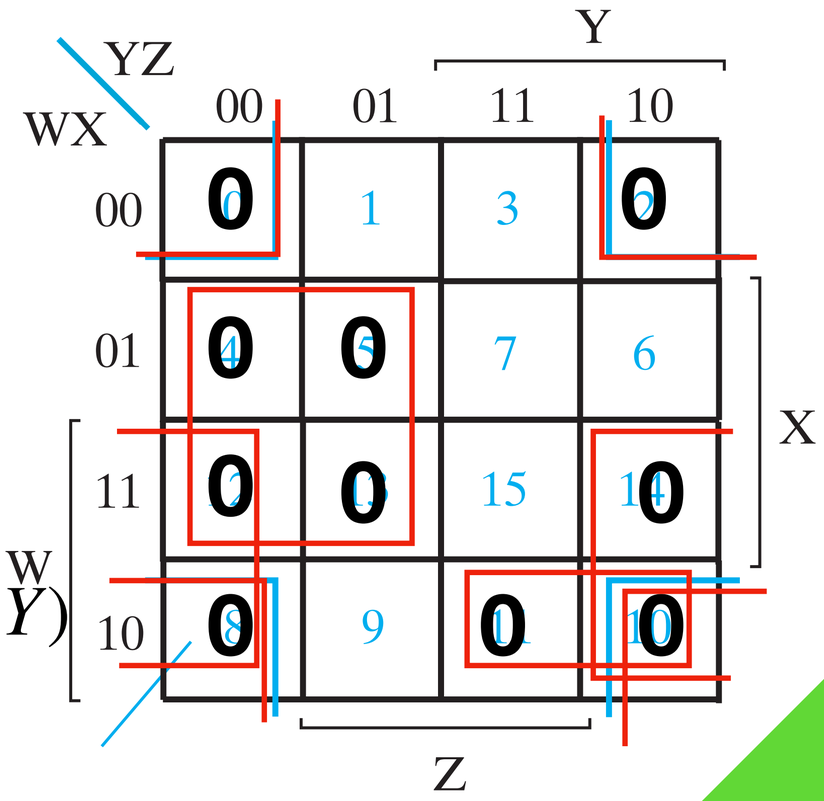
Solution

P3
Product of Sums

Optimise The Following Boolean Expressions in Product-of-Sums Form

B. $F(W,X,Y,Z) = \Pi M(0,2,4,5,8,10,11,12,13,14)$

- $F(W,X,Y,Z) = \overline{\Sigma m(0,2,4,5,8,10,11,12,13,14)}$
$= \overline{X\overline{Y} + \overline{X}\overline{Z} + WY + W\overline{X}\overline{Y}}$
$= (\overline{X} + Y)(X + Z)(\overline{W} + \overline{Y})(\overline{W} + X + Y)$

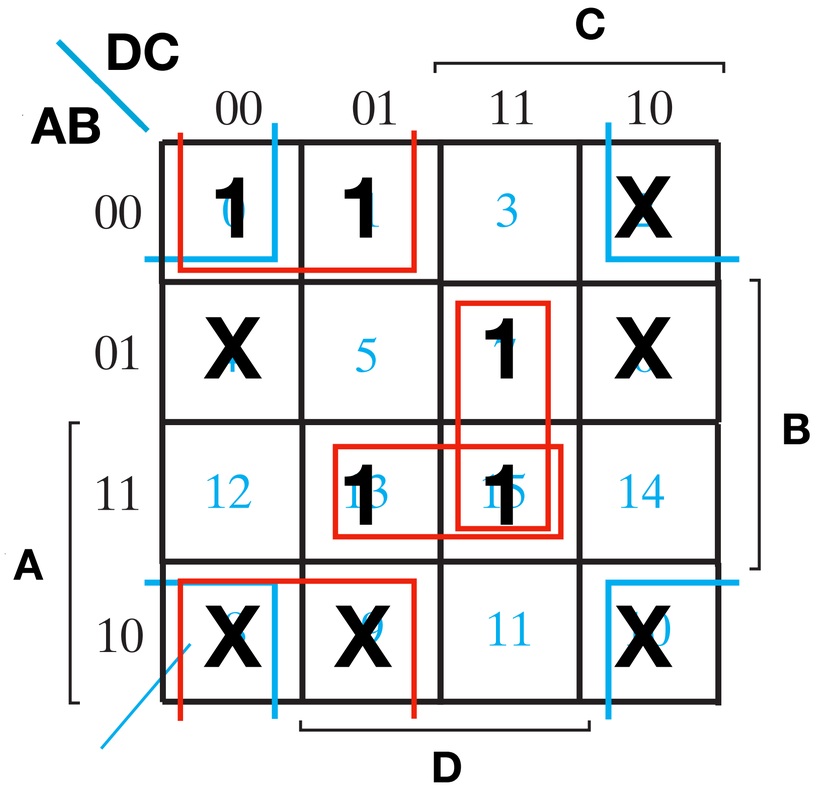


Solution

P4
Don’t Care

Optimise The Following Boolean Expressions with Don’t Care Conditions

A. $F(A,B,C,D) = \Sigma m(0,1,7,13,15),\ d(A,B,C,D) = \Sigma m(2,4,6,8,9,10)$

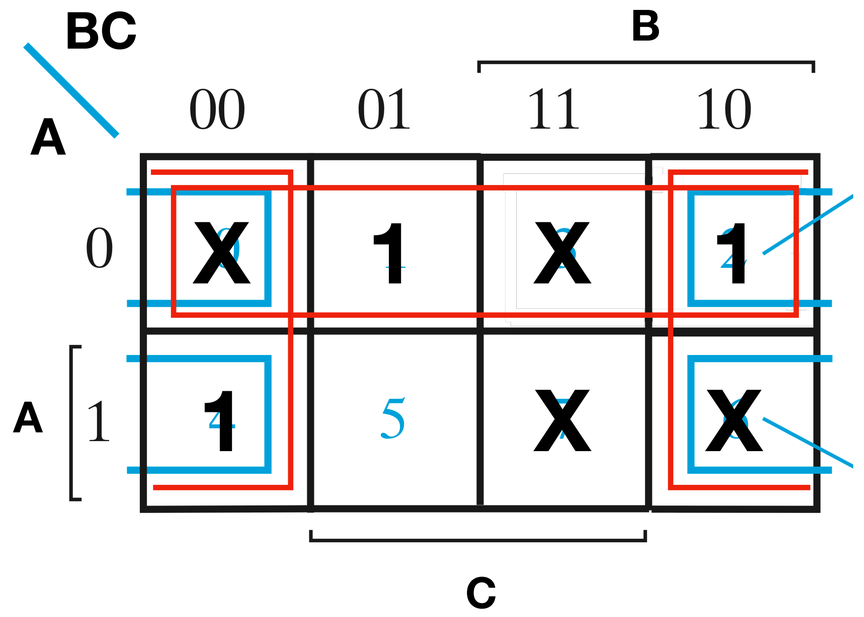


Solution

P4
Don’t Care

Optimise The Following Boolean Expressions with Don’t Care Conditions

B. $F(A, B, C) = \Sigma m(1,2,4),\ d(A, B, C) = \Sigma m(0,3,6,7)$



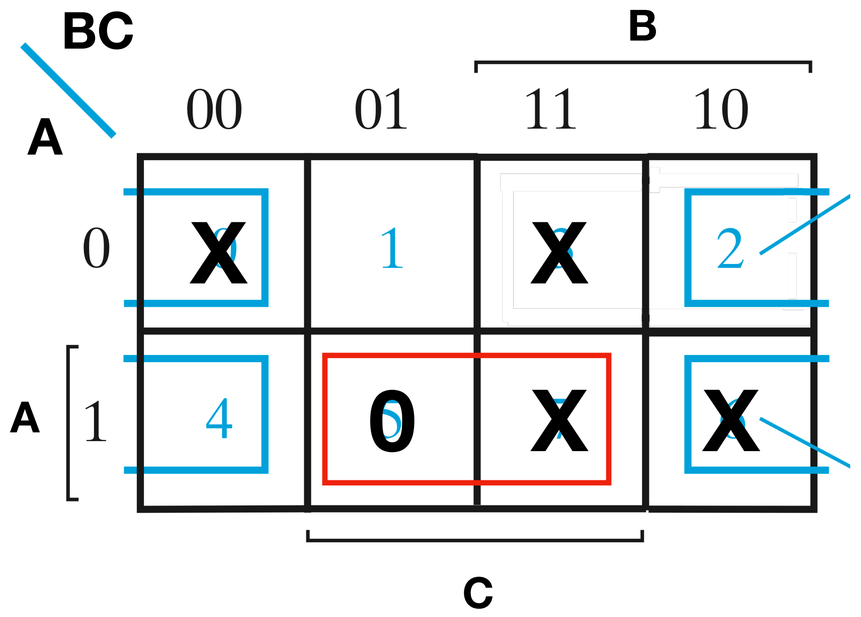
Solution

P4
Don’t Care

Optimise The Following Boolean Expressions with Don’t Care Conditions

B. $F(A, B, C) = \Sigma m(1,2,4),\ d(A, B, C) = \Sigma m(0,3,6,7)$

$\overline{AC}$



Solution

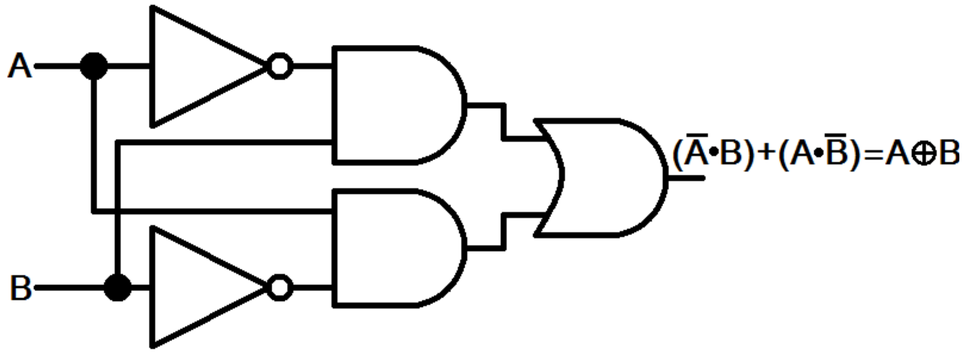
P5
XOR

XOR

A. Write down the boolean expression of XOR in sum-of-products and product-of-sums

- $X \oplus Y = \overline{X}Y + X\overline{Y} = (\overline{X} + \overline{Y})(X + Y)$

B. Draw the circuit diagram implementation with AND, OR, NOT gates for XOR



X	Y	X ⊕ Y
0	0	0
0	1	1
1	0	1
1	1	0

Solution