EGC220

Digital Logic Fundamentals

Simplification Using Karnaugh-Map (K-Map)

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Test 1: Closed book and notes, no calculator

- 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
  - Circuit conversion to all NAND or NOR gates

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Two Variables K-Map

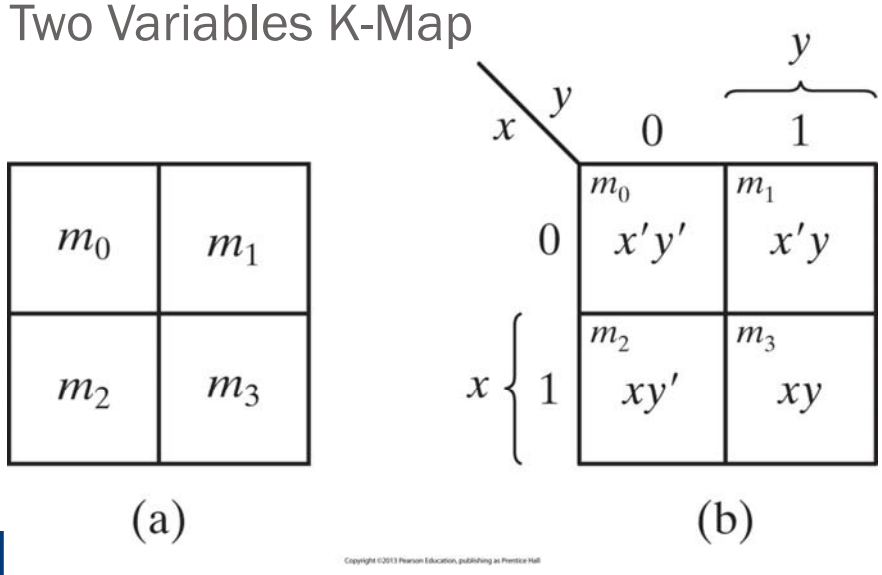

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TABLE 2-12
Two-Variable Function F(A, B)

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

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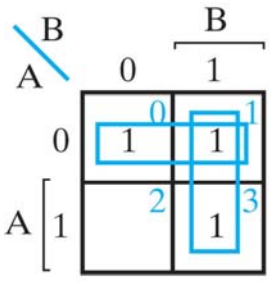
Two Variables K-Map



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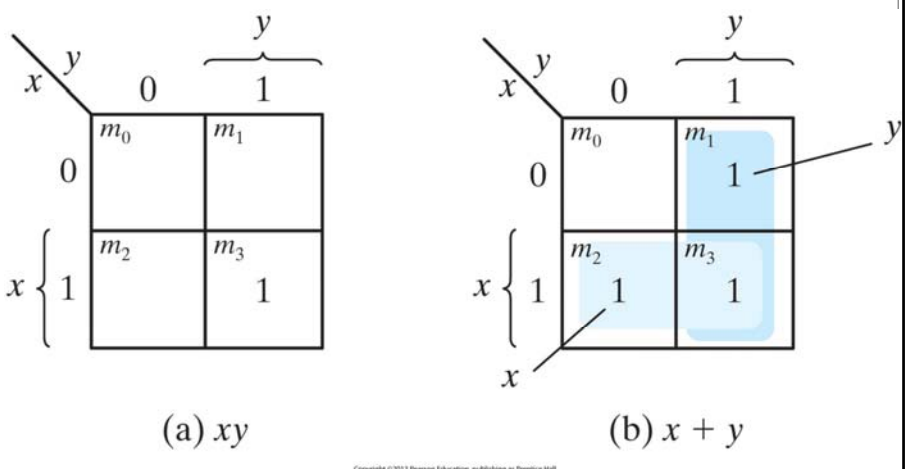
Two Variables K-Map



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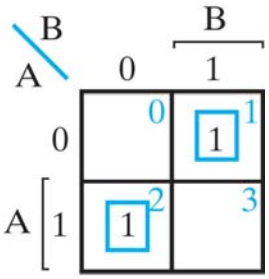
Two Variables K-Map



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Three Variables K-Map

m_0	m_1	m_3	m_2
m_4	m_5	m_7	m_6

(a)

x \ yz	00	01	11	10
0	m_0 $x'y'z'$	m_1 $x'y'z$	m_3 $x'yz$	m_2 $x'yz'$
1	m_4 $xy'z'$	m_5 $xy'z$	m_7 xyz	m_6 xyz'

y (00, 01, 11, 10) z

(b)

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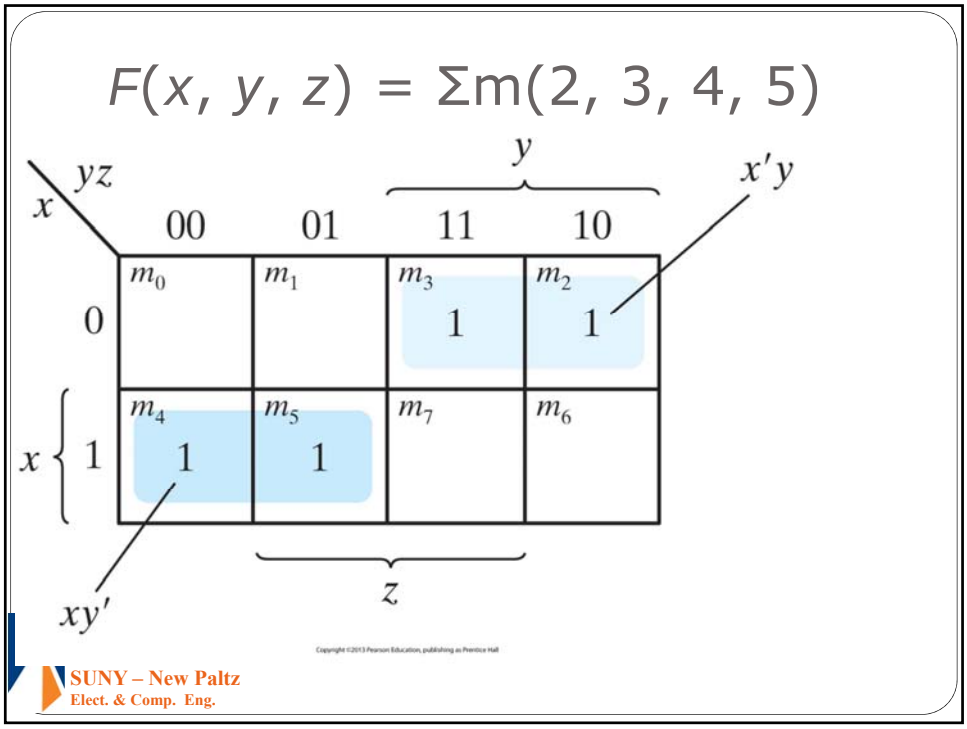
F(x, y, z) = Σm(2, 3, 4, 5)
y
yz
x
00
01
11
10
x'y
m0
m1
m3
m2
1
1
0
m4
m5
m7
m6
1
1
x
1
xy'
z
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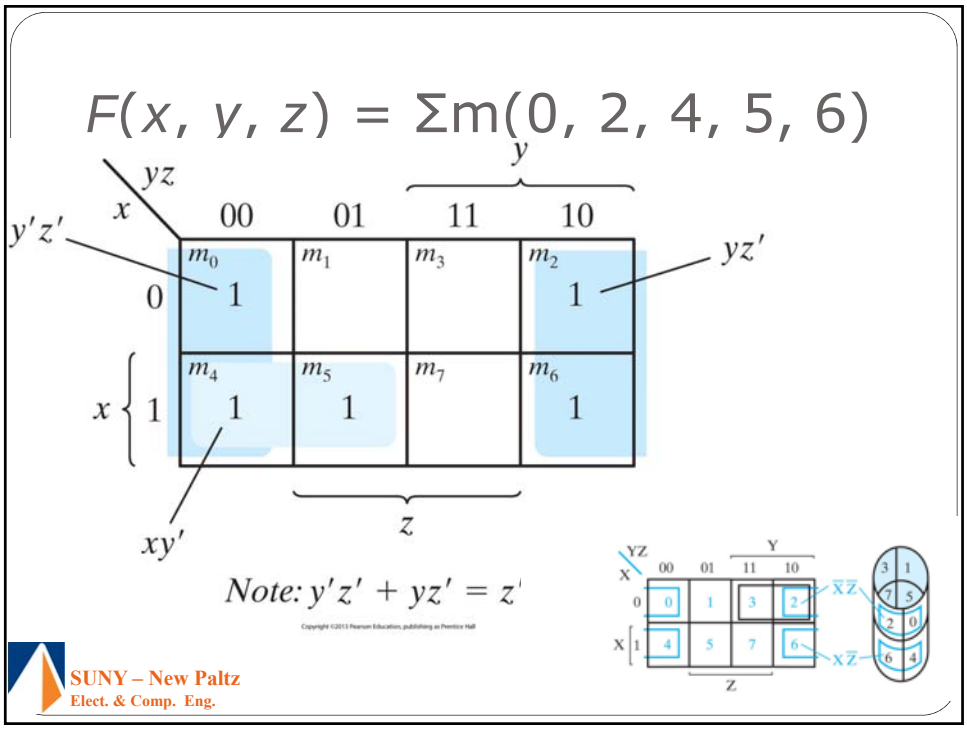
F(x, y, z) = Σm(0, 2, 4, 5, 6)
y
yz
x
00
01
11
10
y'z'
yz'
m0
m1
m3
m2
1
1
0
m4
m5
m7
m6
1
1
1
x
1
xy'
z
Note: y'z' + yz' = z'
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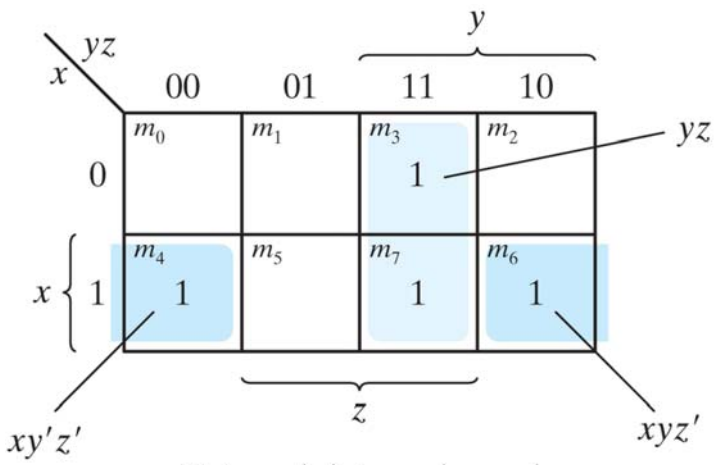
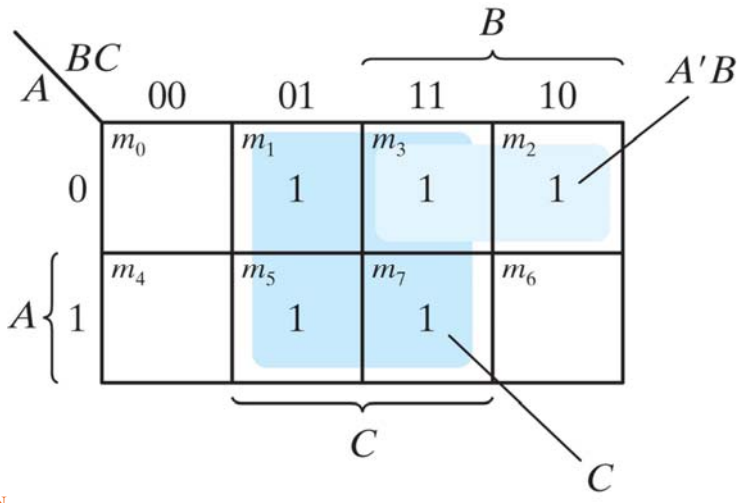
$F(x, y, z) = \Sigma m(3, 4, 6, 7)$

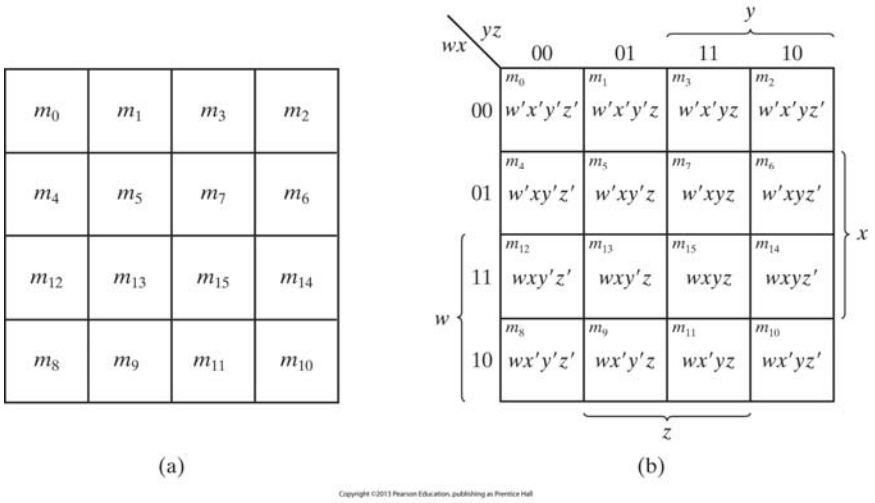


Note: $xy'z' + xyz' = xz'$

$F = A'C + A'B + AB'C + BC$



Four Variables K-Map



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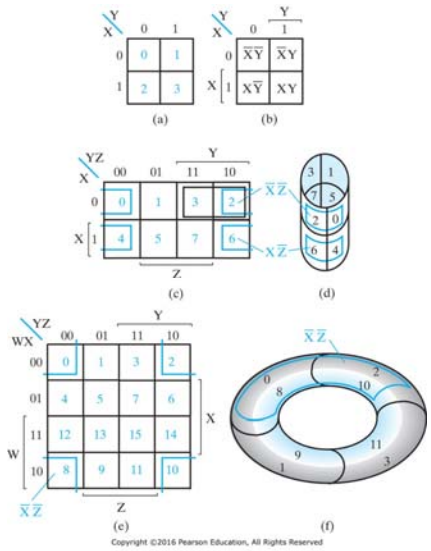
K-Map folding patterns



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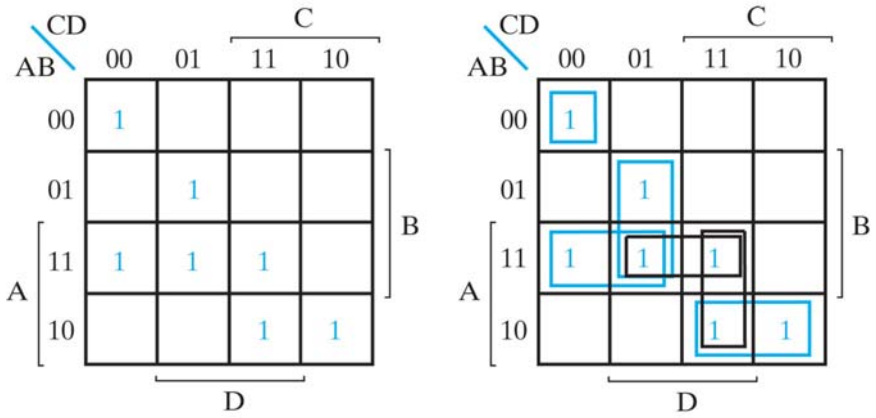
$F(A,B,C,D) = \Sigma m(0,5,10,11,12,13,15)$



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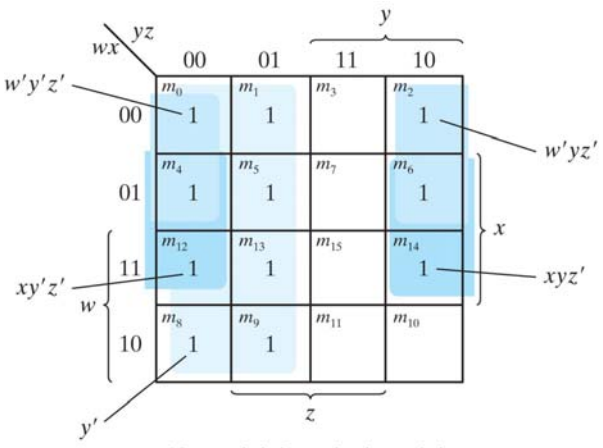
$F(w, x, y, z) = \Sigma m(0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14)$



Note: $w'y'z' + w'yz' = w'z'$
$xy'z' + xyz' = xz'$

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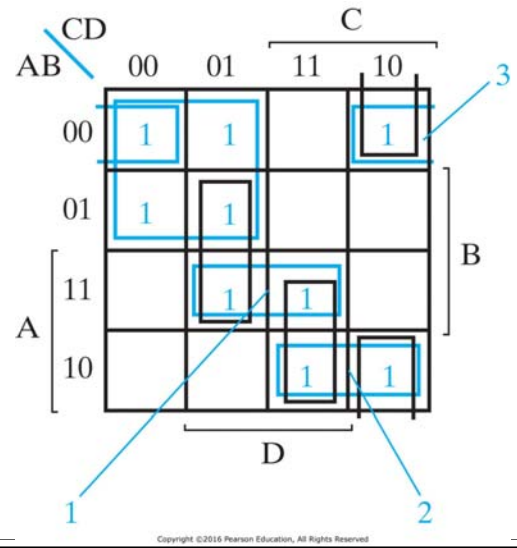
Essential versus non-essential groups



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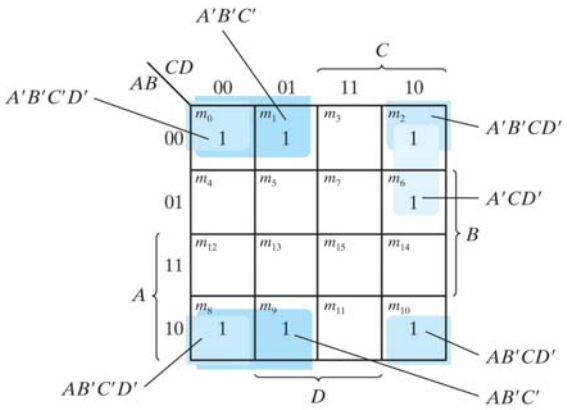
$F=A'B'C' + B'CD' + A'BCD' + AB'C'$



Note: $A'B'C'D' + A'B'CD' = A'B'D'$
$AB'C'D' + AB'CD' = AB'D'$
$A'B'D' + AB'D' = B'D'$
$A'B'C' + AB'C' = B'C'$

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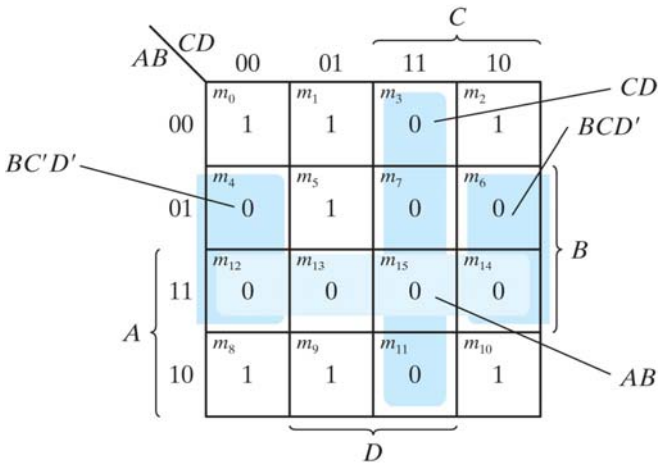
$F(A, B, C, D) = \Sigma m(0, 1, 2, 5, 8, 9, 10)$



Note: $BC'D' + BCD' = BD'$

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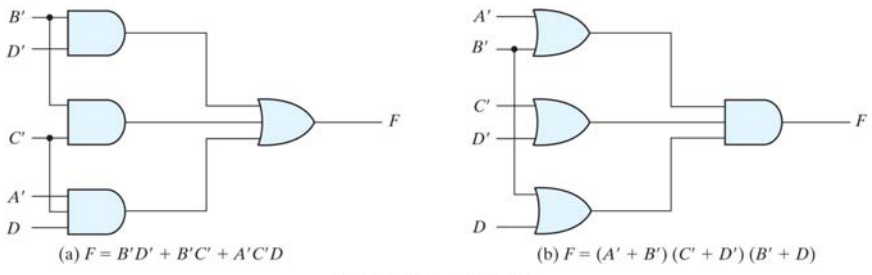
Gate implementations of the function



(a) $F = B'D' + B'C' + A'C'D$

(b) $F = (A' + B')(C' + D')(B' + D)$

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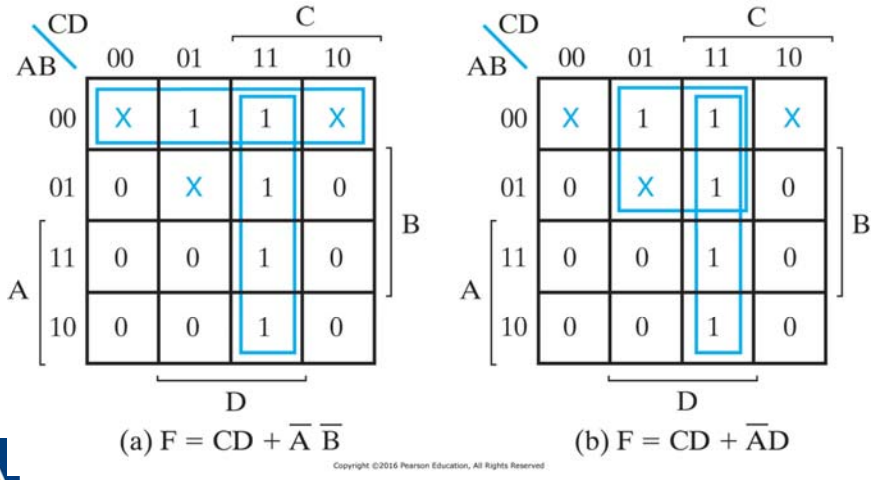
Example with Don't Care Conditions



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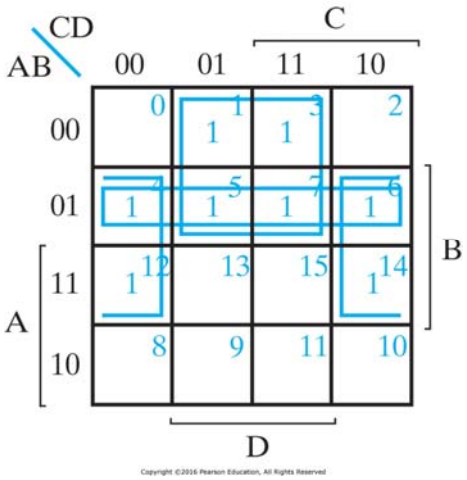
Prime Implicants Example



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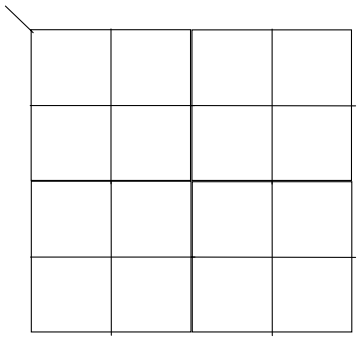
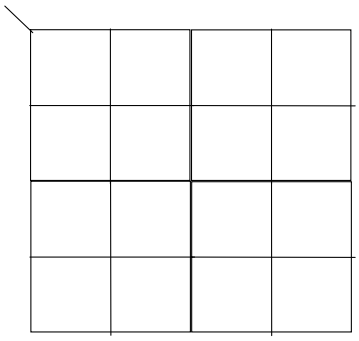
$F(A, B, C, D) = \Sigma m(0, 2, 4, 8) + d(10, 11, 12, 13, 14, 15)$





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Five Variables K-Map

$A = 0$	DE 00	01	D 11	10
BC 00	0	1	3	2
01	4	5	7	6
11	12	13	15	14
10	8	9	11	10

C (rows 01, 11) — B (rows 11, 10) — E (columns 01, 11)

$A = 1$	DE 00	01	D 11	10
BC 00	16	17	19	18
01	20	21	23	22
11	28	29	31	30
10	24	25	27	26

C (rows 01, 11) — B (rows 11, 10) — E (columns 01, 11)

Fig. 3-12 Five-variable Map

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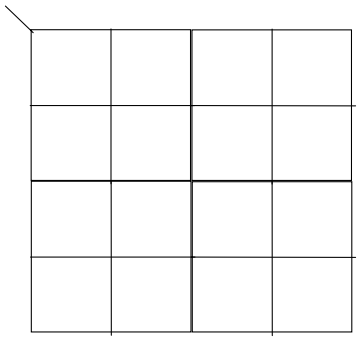
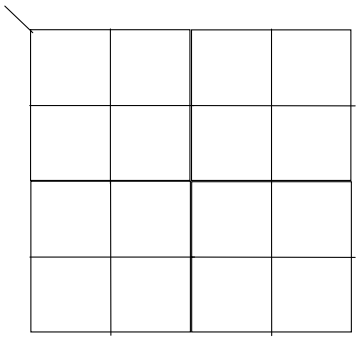
$F(A, B, C, D, E) = \Sigma m(6, 9, 13, 14, 18, 19, 25, 27, 29, 30) + d(2, 5, 10, 11, 20, 22, 26)$





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