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Problem 2-1

Recall that a minterm is a cube in which every variable appears.

A Boolean expression in SOP form is canonical if every cube in the expression has a unique representation in which all of the literals are in complemented or uncomplemented form.

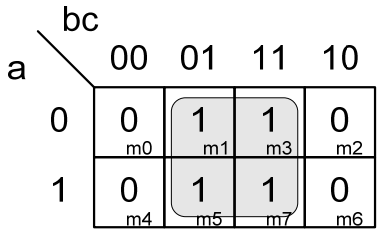
F(a, b, c) = Σ m(1, 3, 5, 7)

Canonical SOP form:

F(a, b, c) = a'b'c + a'bc + ab'c + abc

Also:

K-map for F:



K-map reduction: F = c

F' = m0 + m2 + m4 + m6

F' = a'b'c' + a'bc' + ab'c' + abc'

F = (a'b'c' + a'bc' + ab'c' + abc')'

F = (a'b'c')' (a'bc')' (ab'c')' (abc')'

Canonical POS form:

F = (a + b + c)(a + b' +c) (a' + b + c) (a' + b' +c) = c (Prove by expansion)

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Problem 2-2

$F(a, b, c, d) = \Pi M(0, 1, 2, 3, 4, 5, 12)$

F = (a + b + c + d)(a + b + c + d')(a + b + c' + d)(a + b' + c + d)(a + b' + c + d)(a + b' + c + d')(a' + b' + c + d)

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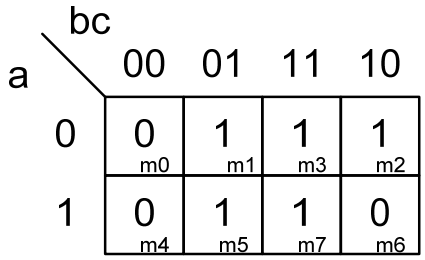
Problem 2-3

F(a, b, c) = a'b + c (Sum of cubes)



F(a, b, c) = m1 + m2 + m3 + m5 + m7

F(a, b, c) = a'b'c + a'bc' + a'bc + ab'c + abc (Sum of minterms)

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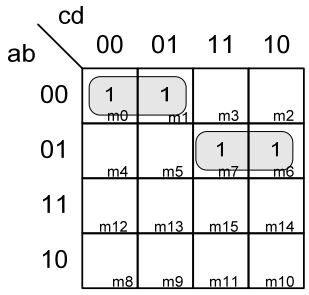
Problem 2-4

F(a, b, c, d) = a'bcd' + a'bcd + a'b'c'd' + a'b'c'd = m6 + m7 + m0 + m1

F(a, b, c, d) = Σ m(0, 1, 6, 7) (Sum of minterms)

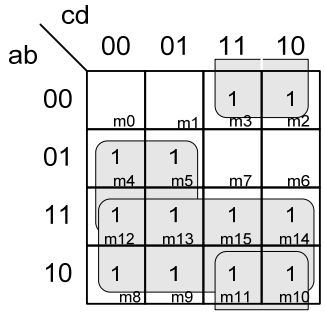
The K-map of F is given below:



F = a'b'c' + a'bc

F'(a, b, c, d) = m2 + m3 + m4 + m5 + m8 + m9 + m10 + m11 + m12 + m13 + m14 + m15

The K-map of F' is given below:



Reduce the K-map to get: F' = b'c + bc' + a

F = (b'c + bc' + a)' = (b'c)'(bc')'(a)'

F = a'bc + a'b'c' (agrees with K-map for F given above)

Using the sum of minterms expression for F, we get the product of maxterms for :

F' = a'b'cd' + a'b'cd + a'bc'd' + a'bc'd + a'bc'd + ab'c'd' + ab'c'd + ab'cd' + ab'cd + abc'd' + abc'd + abcd' + abcd

F =
(a + b + c' + d)(a + b + c' + d')(a + b' + c + d)
(a + b' + c + d')(a + b' + c + d')(a' + b + c + d)
(a' + b + c + d')(a' + b + c' + d)a' + b + c' + d')
(a' + b' + c + d)(a' + b' + c + d')(a' + b' + c' + d)
(a' + b' + c' + d')

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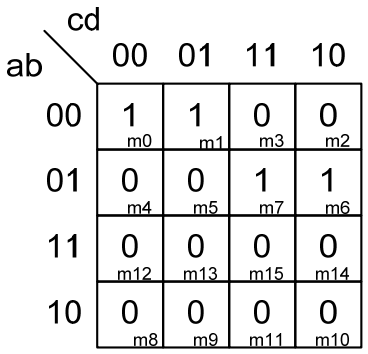
Problem 2-5

G(a, b, c, d) = (a'bcd' + a'bcd + a'b'c'd' + a'b'c'd)'

G'(a, b, c, d) = a'bcd' + a'bcd + a'b'c'd' + a'b'c'd

K-map for G':



G(a, b, c) = Σ m(2, 3, 4, 5, 8, 9, 10 , 11, 12, 13, 14, 15)

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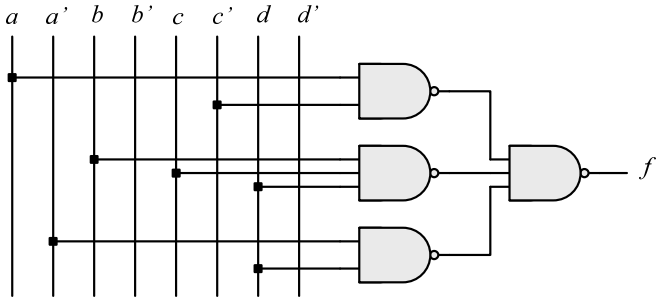
Problem 2-6

f = ac' + bcd + a'd
f' = (ac')' (bcd)' (a'd)'
f = [(ac')' (bcd)' (a'd)']'



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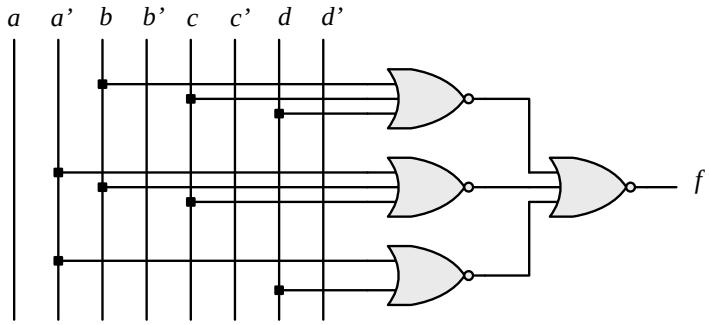
Problem 2-7

f = (b + c + d)(a' + b + c)(a' + d)

f' = (b + c + d)' + (a' + b + c)' + (a' + d)'

f = [(b + c + d)' + (a' + b + c)' + (a' + d)']'



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Problem 2-8

(a) (ab' + a'b)' = (ab')'(a'b)' = (a' + b)(a + b') = a'b' + ab

(b) (b + (cd' + e)a')' = (b)' [cd' + e)a'] ' = b'[(c' + d) e' + a]

(c) [(a' + b + c)(b' + c')(a + c)]' = ab'c' + bc + a'c'

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Problem 2-9

(a) F = a + a'b = a + b

(b) F = a(a' + b) = ab

(c) F = ac + bc' + ab = ac + bc'

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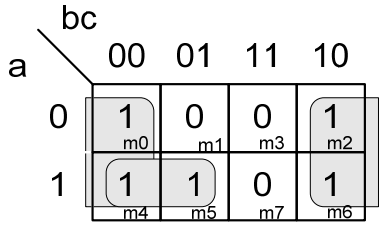
Problem 2-10a

F(a, b, c) = Σ m(0, 2, 4, 5, 6)



F(a, b, c) = Σ m(0, 2, 4, 5, 6) = ab' + c'

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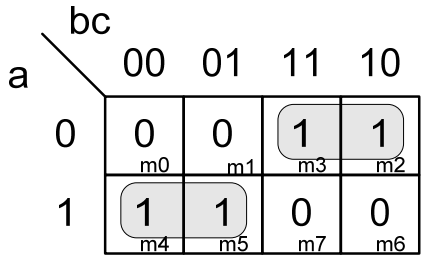
Problem 2-10b

$F(a, b, c) = \Sigma\, m(2, 3, 4, 5)$



$F(a, b, c) = \Sigma\, m(2, 3, 4, 5) = ab' + a'b = a \oplus b$

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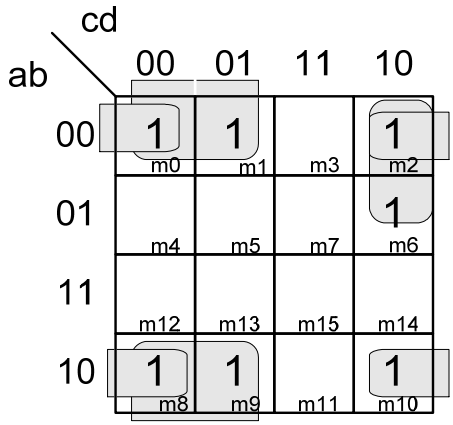
Problem 2-10e

(e) F = a'b'c' + b'cd' + a'bcd' + ab'c'



F = b'c' + b'd' + a'cd'

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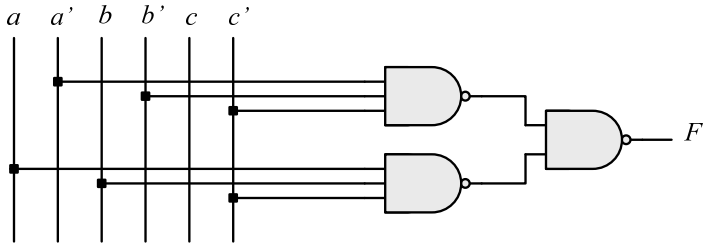
Problem 2-11

F(a, b, c) = Σm(0, 6)

F(a, b, c) = a'b'c' + abc'

F' = [a'b'c' + abc']' = (a'b'c')'(abc')'

F = [(a'b'c')'(abc')']'



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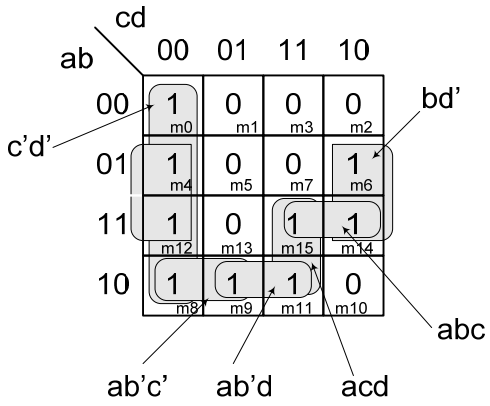
Problem 2-12

Karnaugh Map for f = Σ m(0, 4, 6, 8, 9, 11, 12, 14, 15)



1. Prime implicants are implicants that do not imply any other implicant

Answer: c'd', ab'c', ab'd, acd, abc, bd'

2. Essential prime implicants are prime implicants that cannot be covered by a set of other implicants:

Answer: c'd', bd'

3. A minimal expression consists of the set of essential prime implicants together with other implicants that cover the function:

Answer:

f = c'd' + bd' + ab'd + abc

f = c'd' + bd' + ab'd + acd

f = c'd' + bd' + ab'c' +acd

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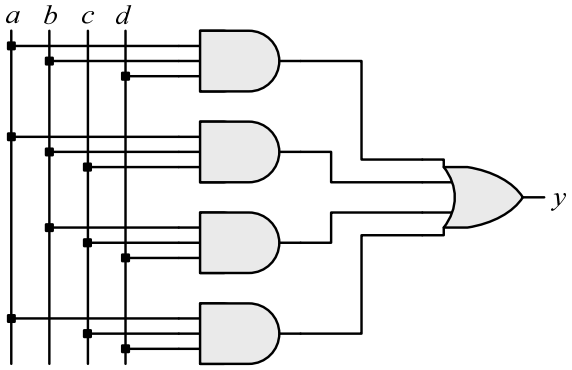
Problem 2-13

a b c d y
0 0 0 0 0
0 0 0 1 0
0 0 1 0 0
0 0 1 1 0
0 1 0 0 0
0 1 0 1 0
0 1 1 0 0
0 1 1 1 1

1 0 0 0 0
1 0 0 1 0
1 0 1 0 0
1 0 1 1 1
1 1 0 0 0
1 1 0 1 1
1 1 1 0 1
1 1 1 1 1

y = abd + abc +bcd + acd



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Problem 2-14

a b c d y
0 0 0 0 0
0 0 0 1 0
0 0 1 0 0
0 0 1 1 0
0 1 0 0 0
0 1 0 1 0
0 1 1 0 0
0 1 1 1 1

1 0 0 0 0
1 0 0 1 0
1 0 1 0 0
1 0 1 1 1
1 1 0 0 0
1 1 0 1 1
1 1 1 0 1
1 1 1 1 1

y = abd + abc +bcd + acd = abcd + abc'd + abcd' + a'bcd + ab'cd