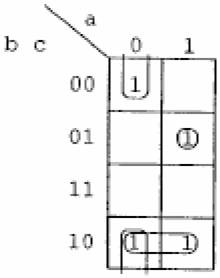
EEC180A DIGITAL SYSTEMS I Winter, 2006.

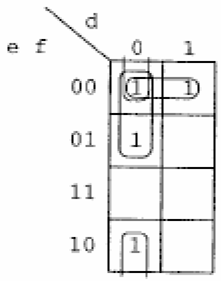
Solutions for Homework # 3

5.3 (a)



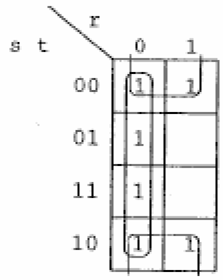
f1 = a'c' + a b'c + b c'

5.3 (b)



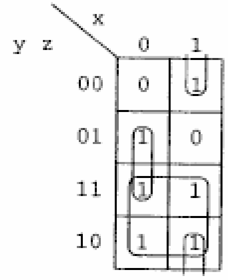
f2 = d'e' + d'f'+ e'f'

5.3 (c)



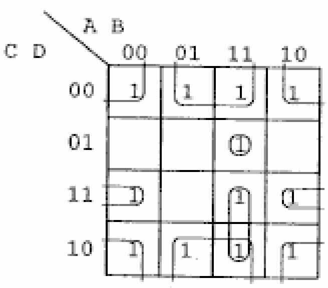
f3 = r' + t'

5.3 (d)



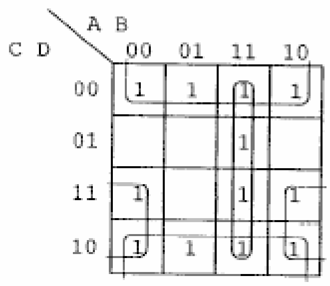
f4 = x'z + y + xz'

5.4 (a)



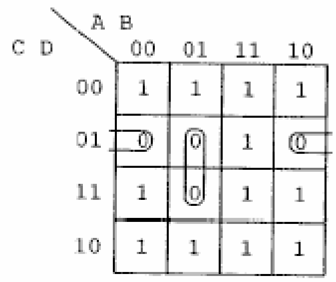
F = B D' + B'C D + A B C + A B C'D + B'D'

5.4 (b)



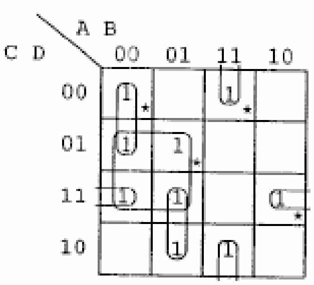
F = D' + B'C + A B

5.4 (c)



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

5.6 (a)



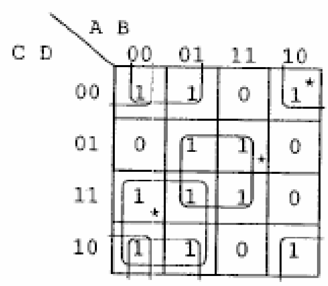
F = A'B'C' + A'D + B'C D + A B D' + B C D'

Alt: F = A'B'C' + A'D + B'C D + A B D' + A'B C

A (*) indicates a minterm that makes the corresponding prime implicant essential.

A'D → m_5; A'B'C' → m_0; B'CD → m_{11}; ABD' → m_{12}

5.6 (b)



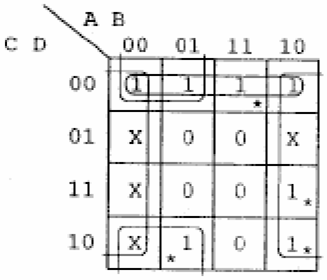
F = A'C + B'D' + B D + A'D'

Alt: F = A'C + B'D' + B D + A'B

(*) Indicates a minterm that makes the corresponding prime implicant essential.

BD → m_{13} or m_{15}; A'C → m_3; B'D' → m_8 or m_{10}

5.6 (c)

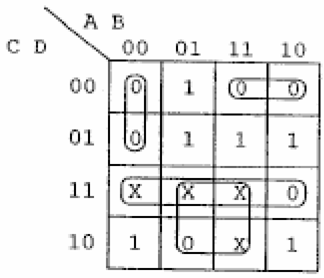


F = A'D' + B' + C'D'

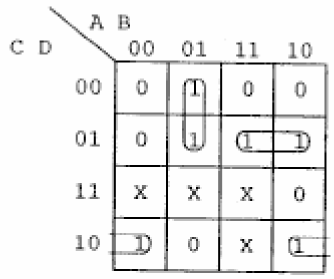
(*) Indicates a minterm that makes the corresponding prime implicant essential.

C'D'→m_{12}; A'D'→m_6; B'→m_{10} or m_{11}

5.8 (a)

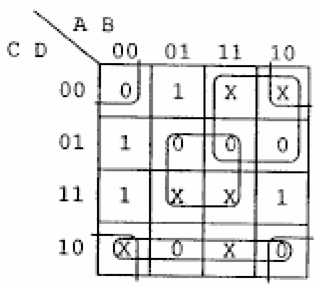


F = (C'+ D') (B'+ C') (A + B + C) (A'+ C + D)



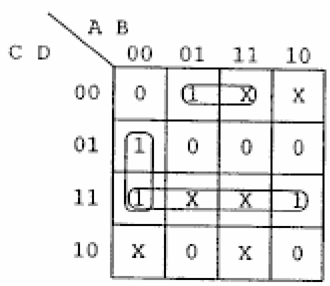
F = A'B C' + A C'D + B'C D'

5.8 (b)



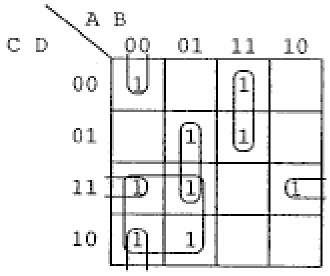
F = (A'+ C) (B'+ D') (B + D) (C'+ D)

Alt: F = (A'+ C) (B'+ D') (B + D) (B'+ C')



F = A'B'D + B C'D' + C D

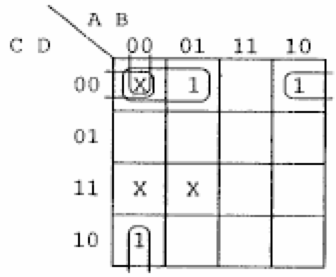
5.19 (a)



F = A B C' + B'C D + A'C + A'B'D' + A'B D

Alt: F = A B C' + B'C D + A'C + A'B'D' + B C'D

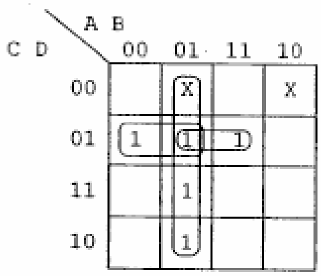
5.19 (b)



F = A'C'D' + B'C'D' + A'B'D'

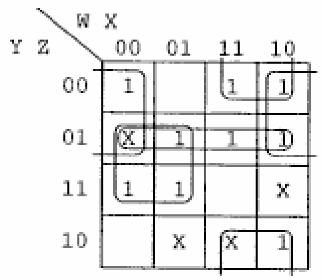
Alt: F = A'C'D' + B'C'D' + A'B'C

5.19 (c)



F = A'C'D + A'B + B C'D

5.19 (d)

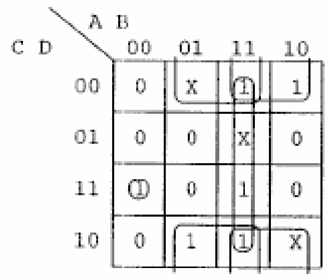


F = X'Y' + W'Z + Y'Z + W Z'

Alt: F = X'Y' + W Y' + W'Z + W Z'

Alt: F = X'Y' + W Y' + W'Z + W X'

5.19 (e)



F = A'B'C D + B D' + A D' + A B

7.1 (a)

cd \ ab	00	01	11	10
00	0	1	0	1
01	0	0	0	1
11	0	1	0	0
10	0	1	0	1

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

Sum of products solution requires 5 gates, 16 inputs

cd \ ab	00	01	11	10
00	0	1	0	1
01	0	0	0	1
11	0	1	0	0
10	0	1	0	1

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

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

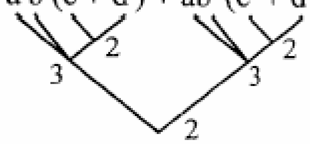
f = (a'+ b') (a + b) (a + c + d') (a'+ c'+ d')

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

Product of sums solution requires 5 gates, 14 inputs, so product of sums solution is minimum.

7.1 (b) Beginning with the minimum sum of products solution, we can get

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

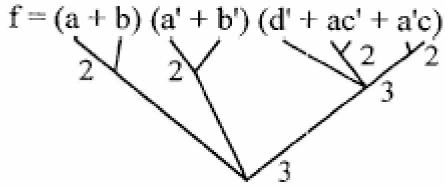


5 gates, 12 inputs

So sum of products solution is minimum.

Beginning with a minimum product of sums solution, we can get

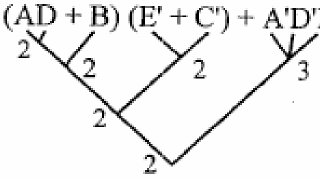
f = (a + b) (a' + b') (d' + ac' + a'c)



6 gates, 14 inputs

7.2 (a) *AC'D + ADE' + BE' + BC' + A'D'E'*
= E' (AD + B) + A'D'E' + C' (AD + B)

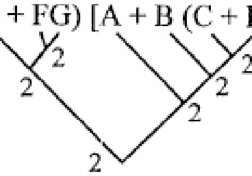
F = (AD + B) (E' + C') + A'D'E'



4 levels, 6 gates, 13 inputs

7.2 (b) *AE + BDE + BCE + BCFG + BDFG + AFG*
= AE + AFG + BE (C + D) + BFG (C + D)

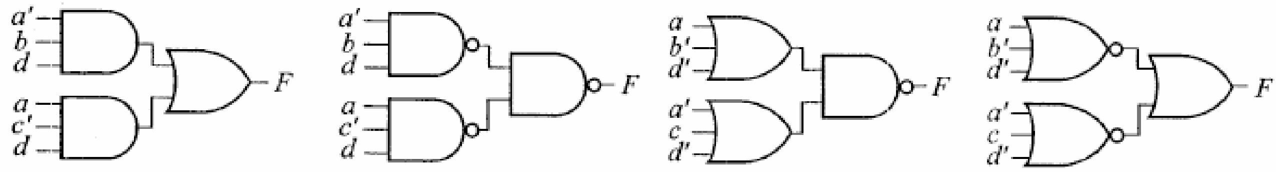
F = (E + FG) [A + B (C + D)]



4 levels, 6 gates, 12 inputs

7.3 $F(a, b, c, d)n = a'bd + ac'd$ or $d(a'b + ac') = d(a + b)(a' + c')$

You can obtain this equation in the product of sums form using a Karnaugh map, as shown below:

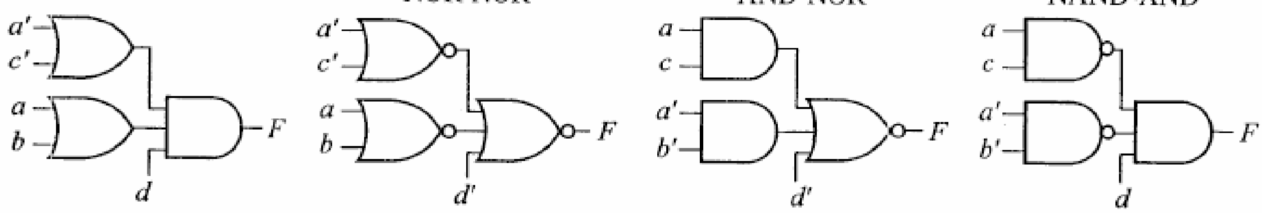


AND-OR: $F=a'bd+ac'd$, $(F')'=[(a'bd+ac'd)']'$

NAND-NAND: $(F')'=[(a'bd)'(ac'd)']'$

OR-NAND: $(F')'=[(a+b'+d')(a'+c+d')]'$

NOR-OR: $(F')'=(a+b'+d')'+(a'+c+d')'$



OR-AND: $F=d(a+b)(a'+c')$, $(F')'=[[d(a+b)(a'+c')]']'$

NOR-NOR: $(F')'=[d'+(a+b)'+(a'+c')']'$

AND-NOR: $(F')'=[d'+a'b'+ac]'$

NAND-AND: $(F')'=d(a'b')'(ac)'$

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

F = A C'D + A'B D

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

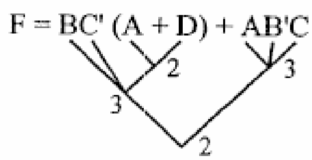
F = (A + B) (D) (A' + C')

7.4 $F(A, B, C, D) = \sum m(5, 10, 11, 12, 13)$

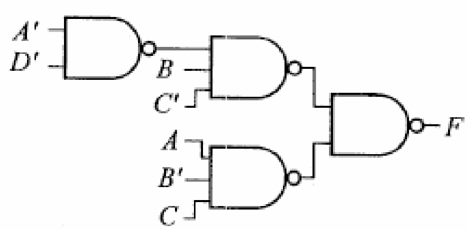
CD \ AB	00	01	11	10
00	0	0	1	0
01	0	1	1	0
11	0	0	0	1
10	0	0	0	1

F = B C'D + A B'C + A B C'

F = ABC' + BC'D + AB'C = BC' (A + D) + AB'C



4 gates, 10 inputs

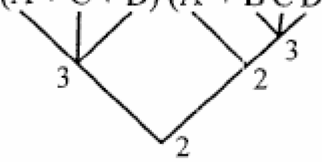


7.5

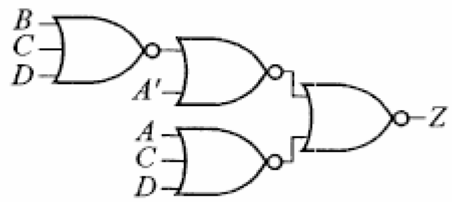
CD \ AB	00	01	11	10
00	0	0	0	1
01	1	1	0	0
11	1	1	0	0
10	1	1	0	0

$Z = (A + C + D)(A' + D')(A' + C')(A' + B')$

$Z = (A + C + D)(A' + B'C'D')$



4 gates, 10 inputs



7.14 (a)

cd \ ab	00	01	11	10
00	0	1	1	1
01	0	1	0	1
11	0	1	0	1
10	1	1	0	1

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

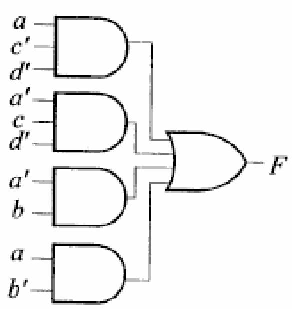
5 gates, 16 inputs

and $f = a'b + ab' + b'cd' + ac'd'$

$f = a'b + ab' + a'cd' + bc'd'$

(two other minimun solutions)

5 gates, 14 inputs *minimal*



7.14 (b) Beginning with the sum of products solution, we get

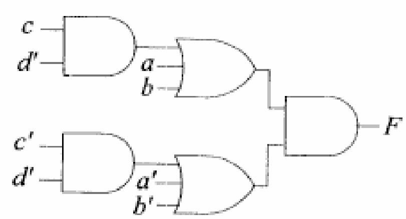
$f = a'b + ab' + d'(a'c + ac')$

$= a'b + ab' + d'(a' + c')(a + c)$ —

6 gates, 14 inputs

But, beginning with the product of sums solution above, we get

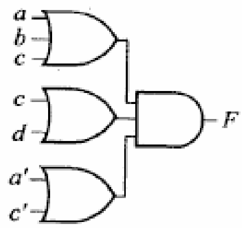
$f = (a + b + cd')(a' + b' + c'd')$ — 5 gates, 12 inputs, which is minimum



7.15 (a) From K-maps:

$F = a'c + bc'd + ac'd$ — 4 gates, 11 inputs

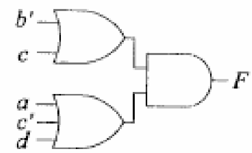
$F = (a + b + c)(c + d)(a' + c')$ — 4 gates, 10 inputs, *minimal*



7.15 (b) From K-maps:

$F = cd + ac + b'c'$ — 4 gates, 9 inputs

$F = (b' + c)(a + c' + d)$ — 3 gates, 7 inputs, *minimal*

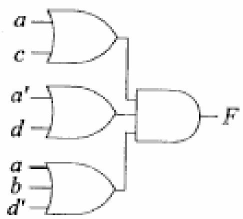


7.15 (c) From K-maps:

$F = ad + a'cd' + bcd$

$\quad = ad + a'cd' + a'bc$ — 4 gates, 11 inputs

$F = (a + c)(a' + d)(a + b + d')$ — 4 gates, 10 inputs, *minimal*

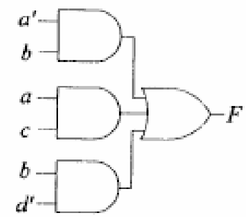


7.15 (d) From K-maps:

$F = a'b + ac + bd'$ — 4 gates, 9 inputs, *minimal*

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

$\quad = (a + b)(a' + c + d')(b + c + d)$ — 4 gates, 11 inputs

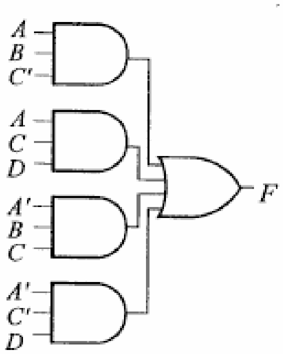


7.16 (a) In this case, multi-level circuits do not improve the solution. From K-maps:

$F = ABC' + ACD + A'BC + A'C'D$ — 5 gates, 16 inputs, *minimal*

$F = (A' + B + C)(A + C + D)(A' + C' + D)(A + B + C')$ — 5 gates, 16 inputs, *also minimal*

Either answer is correct.

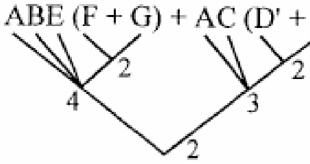


7.16 (b) Too many variables to use a K-map; use algebra. Add ACE by consensus, then use $X + XY = X$

ABCE + ABEF + ACD' + ABEG + ACDE + ACE

= ABEF + ACD' + ABEG + ACE

F = ABE (F + G) + AC (D' + E)



5 gates, 13 inputs, *minimal*