Name_________ Student ID___________ Colleges & Schools__________ Department___________

Pretest Solutions

1. Factor to obtain a product of sums. (Simplify where possible.)

   A′C′D′+ABD′+A′CD+B′D

   Sol.)

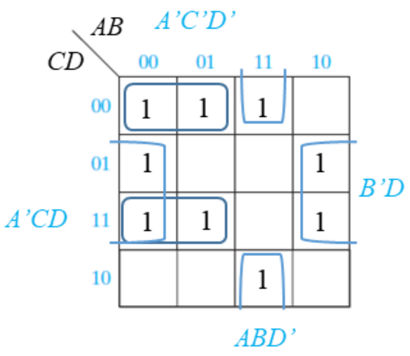
   A′C′D′+ABD′+A′CD+B′D = D′(A′C′+AB) + D(A′C+B′)

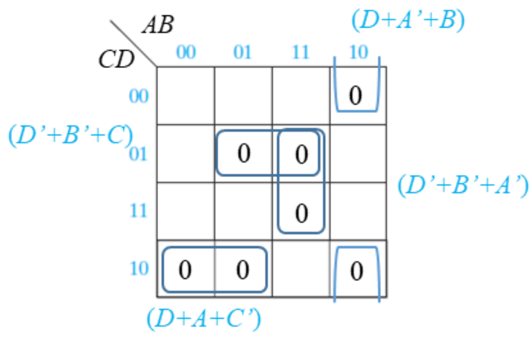
   = D′[(A′+B)(A+C′)] + D[(B′+A′)(B′+C)] ← Using XY+X′Z = (X′+Y)(X+Z)

   = [D+(A′+B)(A+C′][D′+(B′+A′)(B′+C)] ← Using XY+X′Z = (X′+Y)(X+Z)

   = <u>(D+A′+B)(D+A+C′)(D′+B′+A′)(D′+B′+C)</u> ← Using the distributive Law

   Usually factoring of sum-of-products expression (by minterm expansions) gives product-of-sums expression (by maxterm expansions).





2. A switching circuit has three inputs (A, B, C) and one output (F) and is given by

$$F(A, B, C) = A+B'C'+BC$$

(a) Find the truth table for F.

(b) Find the minterm and maxterm expansion for F in algebraic and decimal forms.

(c) Find the minterm and maxterm expansion for F′ in decimal form.

Sol.)

(a)

A	B	C	F	F'
0	0	0	1	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0

(b) $F = A(B+B')(C+C')+(A+A')B'C'+(A+A')(BC) = A(BC+BC'+B'C+B'C')+AB'C'+A'B'C'+ABC+A'BC$

$= ABC+ABC'+AB'C+AB'C'+A'B'C'+A'BC = \sum m\,(0, 3, 4, 5, 6, 7) = \prod M\,(1, 2)$

(c) $F' = \sum m\,(1, 2) = \prod M\,(0, 3, 4, 5, 6, 7)$

3. For this function, find a minimum sum-of-products solution, using the Quine-McCluskey method.

$$f(a, b, c, d) = \sum m(1, 3, 4, 5, 6, 7, 10, 12, 13) + \sum d(2, 9, 15)$$

Sol.)

1	0001✓	1, 3	00-1✓	1, 3, 5, 7	0--1	a'd
2	0010✓	1, 5	0-01✓	~~1, 5, 3, 7~~	~~0--1~~	
4	0100✓	1, 9	-001✓	1, 5, 9, 13	--01	c'd
3	0011✓	2, 3	001-✓	~~1, 9, 5, 13~~	~~--01~~	
5	0101✓	2, 6	0-10✓	2, 3, 6, 7	0-1-	a'c
6	0110✓	2, 10	-010 b'cd'	~~2, 6, 3, 7~~	~~0-1-~~	
9	1001✓	4, 5	010-✓	4, 5, 6, 7	01--	a'b
10	1010✓	4, 6	01-0✓	4, 5, 12, 13	-10-	bc'
12	1100✓	4, 12	-100✓	~~4, 6, 5, 7~~	~~01--~~	
7	0111✓	3, 7	0-11✓	~~4, 12, 5, 13~~	~~-10-~~	
13	1101✓	5, 7	01-1✓	5, 7, 13, 15	-1-1	bd
15	1111✓	5, 13	-101✓	~~5, 13, 7, 15~~	~~-1-1~~	
		6, 7	011-✓			
		9, 13	1-01✓			
		12, 13	110-✓			
		7, 15	-111✓			
		13, 15	11-1✓			
		13, 15	11-1✓			

Prime implicants: b'cd', a'd, c'd, a'c, a'b, bc', bd

Prime implicant chart: Notice that when forming the prime implicant chart, the don't care terms are not listed at the top

		1	3	4	5	6	7	10	12	13
1, 3, 5, 7	a'd	×	×		×		×			
1, 5, 9, 13	c'd	×			×					×
2, 3, 6, 7	a'c		×			×	×			
4, 5, 6, 7	a'b			×	×	×	×			
4, 5, 12, 13	bc'			×	×				⊗	×
5, 7, 13, 15	bd				×		×			×
2, 10	b'cd'							⊗		

Essential Prime Implicant: the essential prime implicants are chosen first because all essential prime implicants must be included in every minimum sum. Here, the essential prime implicants are bc'(minterm 12), b'cd' (minterm 10).

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

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

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

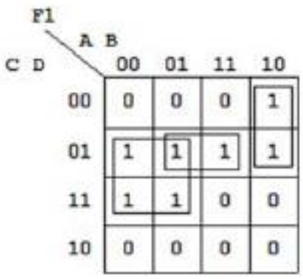
4. Find a minimum 2-level NAND gate circuit to simultaneously realize

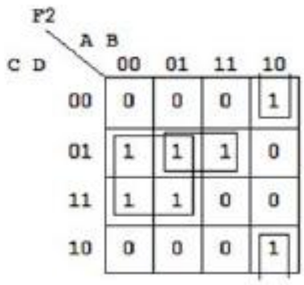
$F_1(A, B, C, D) = \sum m\,(1, 3, 5, 7, 8, 9, 13)$

$F_2(A, B, C, D) = \sum m\,(1, 3, 5, 7, 8, 10, 13)$

(Hint: Minimum solution has 6 gates)

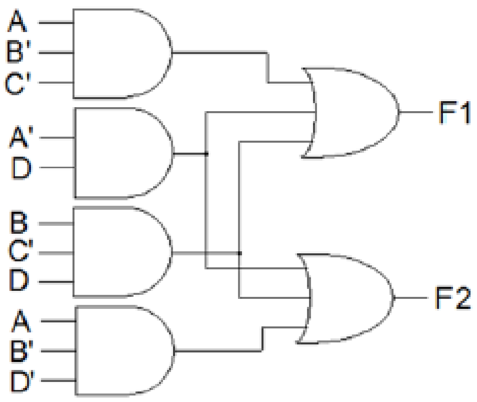
Sol.)

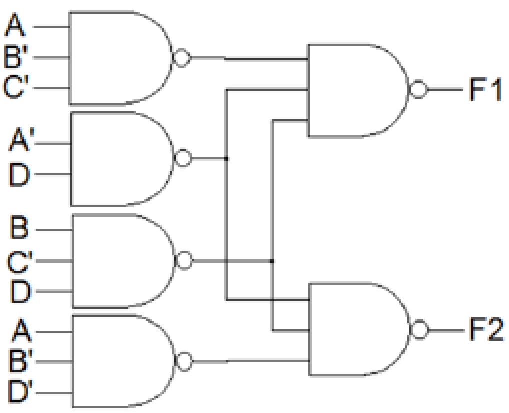


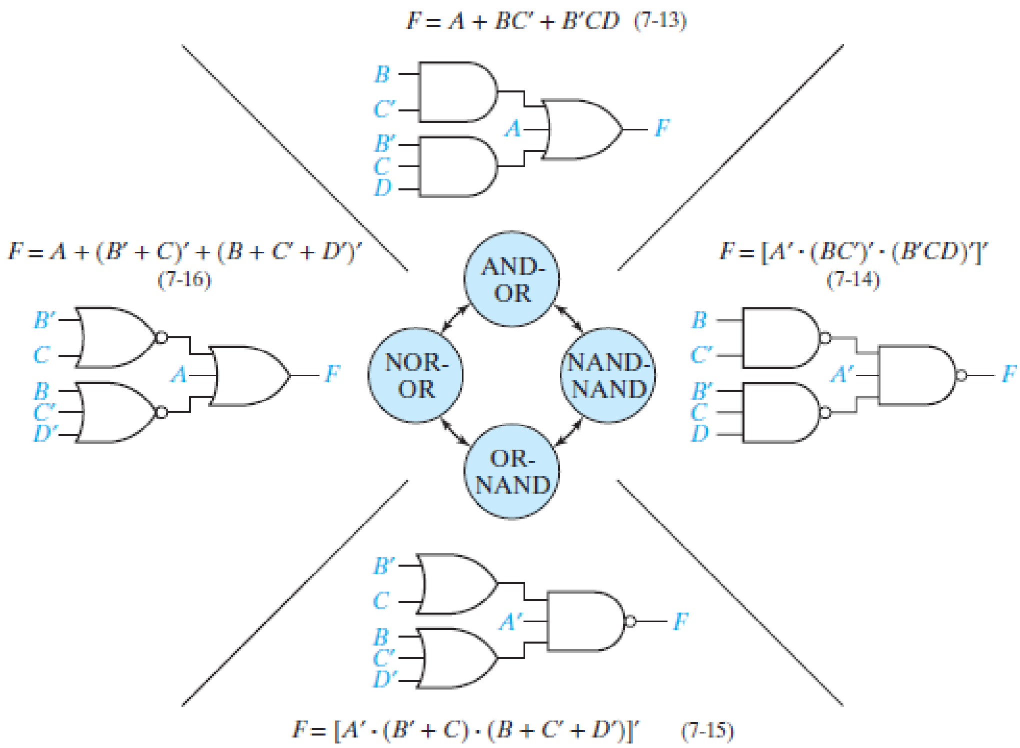


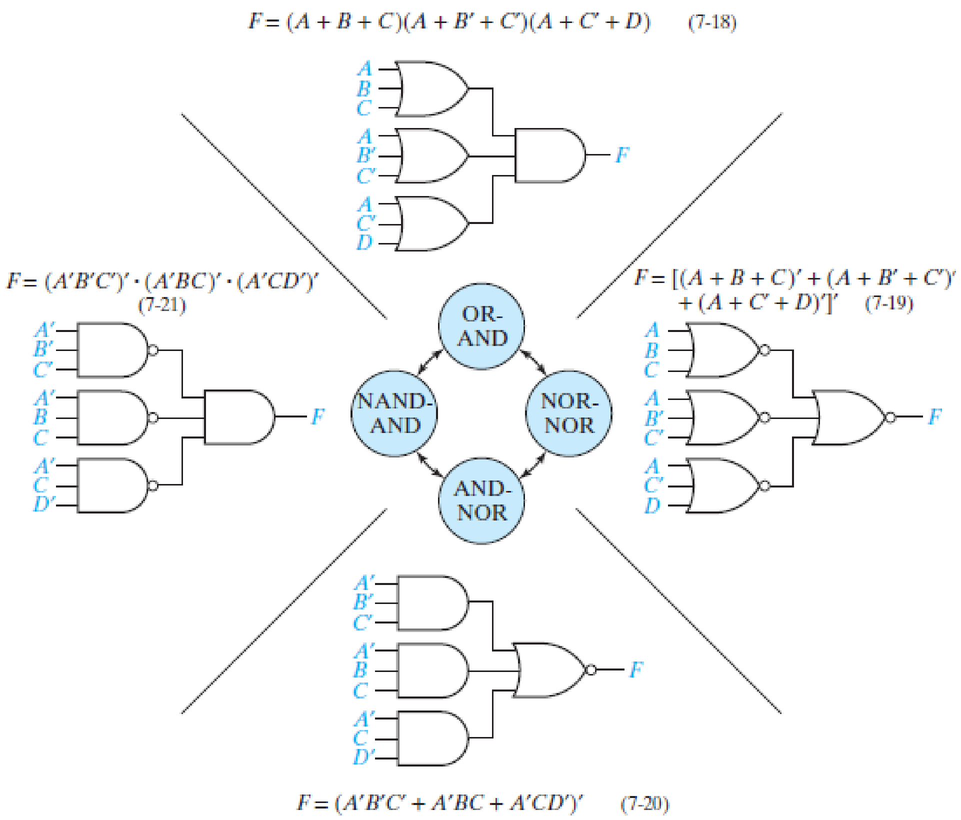
$F_1 = A'D + BC'D + AB'C'$

$F_2 = A'D + BC'D + AB'D'$






F = A + BC′ + B′CD (7-13)
F = A + (B′ + C)′ + (B + C′ + D′)′ (7-16)
F = [A′ · (BC′)′ · (B′CD)′]′ (7-14)
F = [A′ · (B′ + C) · (B + C′ + D′)]′ (7-15)
AND-OR
NOR-OR
NAND-NAND
OR-NAND
B
C′
B′
C
D
A
F
A′


F = (A + B + C)(A + B′ + C′)(A + C′ + D) (7-18)
F = (A′B′C′)′ · (A′BC)′ · (A′CD′)′ (7-21)
F = [(A + B + C)′ + (A + B′ + C′)′ + (A + C′ + D)′]′ (7-19)
F = (A′B′C′ + A′BC + A′CD′)′ (7-20)
OR-AND
NAND-AND
NOR-NOR
AND-NOR
A
B
C
B′
C′
D
A′
D′
F