EEC180A DIGITAL SYSTEMS I Winter, 2006.

Solutions for Homework # 2

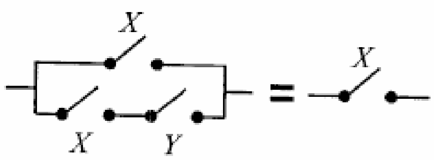
2.1 (a) $X(X' + Y) = XX' + XY = 0 + XY = XY$

(b) $X + XY = X(1 + Y) = X(1) = X$

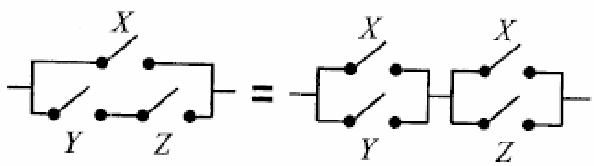
(c) $XY + XY' = X(Y + Y') = X(1) = X$

(d) $(A + B)(A + B') = AA + AB' + AB + BB' = A + AB' + AB + BB'$
$= A(1 + B + B') + 0 = A(1) = A$

2.2 (a) In both cases, if X = 0, the transmission is 0, and if X = 1, the transmission is 1.



2.2 (b) In both cases, if X = 0, the transmission is YZ, and if X = 1, the transmission is 1.



2.3 (a) 1 (Theorem 5)

(b) $CD + AB'E$ (Theorem 8D) (technically, we also used Theorem 3D)

(c) AF (Theorem 9)

(d) $C + D'B + A'$ (Theorem 11D)

(e) $A'B + D$ (Theorem 10D)

(f) $A + BC + DE + F$ (Theorem 11D)

2.4 (a) $F = [(A\cdot 1) + (A\cdot 1)] + E + BCD = A + E + BCD$

2.4 (b) $Y = (AB' + (AB + B))\,B + A = (AB' + B)\,B + A$
$= (A + B)\,B + A = AB + B + A = A + B$

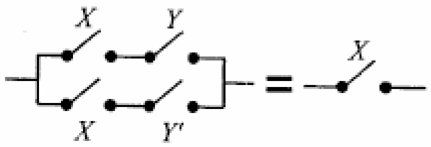
2.5 (a) $(A + B)(C + B)(D' + B)(ACD' + E)$
$= (AC + B)(D' + B)(ACD' + E)$ By Th. 8D
$= (ACD' + B)(ACD' + E)$ By Th. 8D
$= ACD' + BE$ By Th. 8D

2.5 (b) $(A' + B + C')(A' + C' + D)(B' + D')$
$= (A' + C' + BD)(B' + D')$
{By Th. 8D with $X = A' + C'$}
$= A'B' + B'C' + B'BD + A'D' + C'D' + BDD'$
$= A'B' + A'D' + C'B' + C'D'$

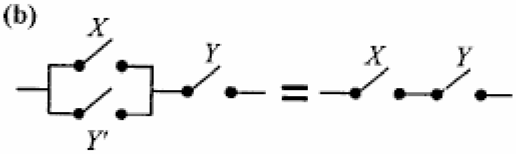
2.6 (a) $AB + C'D' = (AB + C')(AB + D')$
$= (A + C')(B + C')(A + D')(B + D')$

2.6 (b) $WX + WY'X + ZYX = X(W + WY' + ZY)$
$= X(W + ZY)$ {By Th. 10}
$= X(W + Z)(W + Y)$

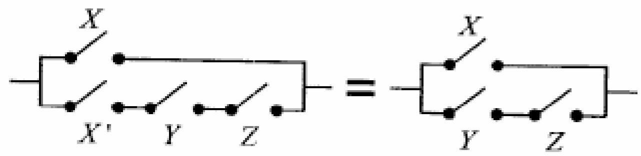
2.10 (a)



2.10 (b)



2.10 (c)



2.11 (a) $A'B'C + (A'B'C)' = 1$ By Th. 5

2.11 (b) $A(B + C'D) + B + C'D = B + C'D$ By Th. 10

2.11 (c) $A + B + C'D(A + B)' = A + B + C'D$
By Th. 11D

3.13 (a) $(A' + C' + D)(A' + C)(B + C' + D')(A' + B + C)(C + D)$
$= (C' + DB + A'D')(C + A'D) = C(BD + A'D') + (C'A'D)$ {Using $XY + X'Z = (X + Z)(X' + Y)$ with $X = C$}
$= CBD + CA'D' + C'A'D$

3.13 (b) $(A' + B' + C')(A + C + D')(A + B)(A' + D)(A' + C + D)$
$= [A' + D(B' + C')][A + B(C + D')] = AD(B' + C') + A'B(C + D') = ADB' + ADC' + A'BC + A'BD'$

3.13 (c) $(A' + B' + C)(A + D')(A' + B + D')(A + B)(A + C + D')$
$= [A' + (B' + C)(B + D')](A + BD') = (A' + BC + B'D')(A + BD')$ {By Th. 14 with $X = B$}
$= A(BC + B'D') + A'BD'$ {By Th. 14 with $X = A$}
$= ABC + AB'D' + A'BD'$

3.14 (a) $ABCD' + A'B'CD + CD' = A'B'CD + CD' = C(A'B'D + D') = C(D' + A'B')$ {By Th. 11D with $Y = D'$} $= CD' + A'B'C$

3.14 (b) $AB'C' + C\underline{D'} + BC'\underline{D'} = AB'C' + D'(\underline{C} + B\underline{C'}) = AB'C' + D'(C + B) = AB'C' + CD' + BD'$

3.14 (c) $(A + \underline{B'})(A' + \underline{B'} + D)(\underline{B'} + C + D') = B' + \underline{A}(\underline{A'} + D)(C + D') = B' + A\underline{D}(C + \underline{D'}) = B' + ACD$

3.14 (d) $(\underline{A'} + B + \underline{C'} + D)(\underline{A' + C'} + D + E)(\underline{A' + C'} + D + E')AC$
$= [A' + C' + (B + D)(\underline{D + E})(\underline{D + E'})]AC$ {By Th. 8D twice with $X = A' + C'$} $= [A' + C' + (B + D)D]AC$
$= [\underline{A'} + \underline{C'} + D]\underline{AC} = ACD$

3.15 (c) $A\underline{B} + A'\underline{B'}C + \underline{B'}C'D + \underline{B}C'D' = B'[A'\underline{C} + \underline{C'}D] + B[\underline{A + C'D'}] = \underline{B'}[(C + D)(C' + A')] + \underline{B}[(A + C')(A + D')]$
$= [B + (C + D)(C' + A')][B' + (A + C')(A + D')] = (B + C + D)(B + C' + A')(B' + A + C')(B' + A + D')$

3.15 (d) $A'C'\underline{D} + AB'\underline{D'} + A'C\underline{D'} + B\underline{D} = D(\underline{A'C' + B}) + D'(\underline{A}B' + \underline{A'}C) = \underline{D}(B + A')(B + C') + \underline{D'}(B' + A')(A + C)$
$= [D' + (B + A')(B + C')][D + (B' + A')(A + C)] = (D' + B + A')(D' + B + C')(D + B' + A')(D + A + C)$

3.15 (e) $\underline{W}X\underline{Y} + \underline{W}X'\underline{Y} + \underline{WY}Z + XYZ' = WY(\underline{X} + \underline{X'} + Z) + XYZ' = W\underline{Y} + X\underline{Y}Z' = Y(W + XZ') = Y(W + X)(W + Z')$

3.18 (a) $BC'D' + ABC' + AC'D + AB'D + A'BD' = BC'D' + ABC' + AB'D + A'BD' = ABC' + AB'D + A'BD'$

3.18 (b) $W'Y' + WYZ + XY'Z + WX'Y + WXZ = W'Y' + WYZ + XY'Z + WX'Y + WXZ = W'Y' + WYZ + WX'Y + WXZ$

$= W'Y' + WX'Y + WXZ$

3.18 (c) $(B + C + D)(A + B + C)(A' + C + D)(B' + C' + D') = (A + B + C)(A' + C + D)(B' + C' + D')$

3.18 (d) $W'XY + WXZ + WY'Z + W'Z' = W'XY + WXZ + WY'Z + W'Z' + XYZ = WY'Z + W'Z' + XYZ$

XYZ (add consensus term)

3.22 (a) $xy + x'yz' + yz = y(x + x'z') + yz = xy + yz' + yz$

$= xy + y = y$

Alternate Solution: $xy + x'yz' + yz = y(x + x'z' + z)$

$= y(x + z' + z) = y(x + 1) = y$

3.22 (b) $(xy' + z)(x + y')z = (xy' + xz + y'z)z$

$= xy'z + xz + y'z = xz + y'z$

Alternate Solution: $(xy' + z)(x+y')z = z(x + y')$

$= zx + zy'$

3.22 (c) $xy' + z + (x' + y)z'$

$= x'y + (x' + y)$ {By Th. 11D with $Y = z$}

$= xy' + x' + y = x + x' + y = 1 + y = 1$

Alt.: $xy' + z + (x' + y)z' = (xy' + z) + (xy' + z)' = 1$

3.22 (d) $a'd(b' + c) + a'd'(b + c') + (b' + c)(b + c')$

$= a'b'd + a'cd + a'bd' + a'c'd' + b'c' + bc$

$= a'b'd + a'bd' + b'c' + bc'$

Other Solutions: $b'c' + bc + a'c'd' + a'b'd$

$b'c' + bc + a'c'd' + a'cd$

$b'c' + bc + a'bd' + a'cd$

3.23 (a) $A'C'D' + AC' + BCD + A'CD' + A'BC + ABC'$

$= A'D' + AC' + BCD + A'BC$ consensus

$= A'D' + AC' + BCD$

3.23 (b) $A'B'C' + ABD + A'C + A'CD' + AC'D + AB'C'$

$= B'C' + ABD + A'C + AC'D$

$= B'C' + ABD + A'C$

4.1 *See FLD p. 628 for solution.*

4.9 (a) $F = abc' + b'(a + a')(c + c') = abc' + ab'c + ab'c' + a'b'c + a'b'c'$; $F = \sum m(0, 1, 4, 5, 6)$

4.9 (b) Remaining terms are maxterms: $F = \prod M(2, 3, 7)$

4.9 (c) Maxterms of F are minterms of F':
$F' = \sum m(2, 3, 7)$

4.9 (d) Minterms of F are maxterms of F':
$F' = \prod M(0, 1, 4, 5, 6)$

4.25 (a) If don't cares are changed to (1, 1), respectively,
$F_1 = A'B'C' + ABC + A'B'C + AB'C$
$= A'B' + AC,$

4.25 (c) If don't cares are changed to (1, 1), respectively
$F_3 = (A + B + C)(A + B + C') = A + B$

4.25 (b) If don't cares are changed to (1, 0), respectively
$F_2 = A'B'C' + A'BC' + AB'C' + ABC' = C'$

4.25 (d) If don't cares are changed to (0, 1), respectively
$F_4 = A'B'C' + A'BC + AB'C' + ABC$
$= B'C' + BC$

4.28

ABCD	1's	*XYZ*
0 0 0 0	0	0 0 0
0 0 0 1	1	0 0 1
0 0 1 0	1	0 0 1
0 0 1 1	2	0 1 0
0 1 0 0	1	0 0 1
0 1 0 1	2	0 1 0
0 1 1 0	2	0 1 0
0 1 1 1	3	0 1 1
1 0 0 0	1	0 0 1
1 0 0 1	2	0 1 0
1 0 1 0	2	0 1 0
1 0 1 1	3	0 1 1
1 1 0 0	2	0 1 0
1 1 0 1	3	0 1 1
1 1 1 0	3	0 1 1
1 1 1 1	4	1 0 0

(a) $X = ABCD$

$Y = A'B'CD + A'BC'D + A'BCD' + A'BCD + AB'C'D + AB'CD' + AB'CD + ABC'D' + ABC'D + ABCD'$

$Z = A'B'C'D + A'B'CD' + A'BC'D' + A'BCD + AB'C'D' + AB'CD + ABC'D + ABCD'$

4.28 (b) $Y = (A + B + C + D)(A + B + C + D')(A + B + C' + D)(A + B' + C + D)(A' + B + C + D)(A' + B' + C' + D')$

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

4.29

ABCD	*WXYZ*
0 0 0 0	0 0 1 1
0 0 0 1	0 1 0 0
0 0 1 0	0 1 0 0
0 0 1 1	0 1 0 1
0 1 0 0	0 1 0 0
0 1 0 1	0 1 0 1
0 1 1 0	0 1 0 1
0 1 1 1	0 1 1 0
1 0 0 0	0 1 0 0
1 0 0 1	0 1 0 1
1 0 1 0	0 1 0 1
1 0 1 1	0 1 1 0
1 1 0 0	0 1 0 1
1 1 0 1	0 1 1 0
1 1 1 0	0 1 1 0
1 1 1 1	0 1 1 1

(a) $X = A'B'C'D + A'B'CD' + A'B'CD + A'BC'D' + A'BC'D + A'BCD' + A'BCD + AB'C'D' + AB'C'D + AB'CD' + AB'CD + ABC'D' + ABC'D + ABCD' + ABCD$

$Y = A'B'C'D' + A'BCD + ABC'D + ABCD' + ABCD$

$Z = A'B'C'D' + A'B'CD + A'BC'D + A'BCD' + AB'C'D + AB'CD' + AB'CD + ABC'D' + ABCD$

4.29 (b) $Y = (A + B + C + D')(A + B + C' + D)(A + B + C' + D')(A + B' + C + D)(A + B' + C + D')(A + B' + C' + D)(A' + B + C + D)(A' + B + C + D')(A' + B + C' + D)(A' + B + C' + D')(A' + B' + C + D)$

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