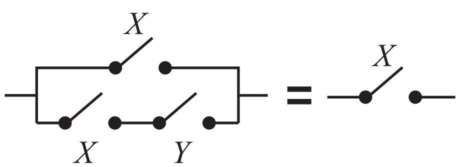
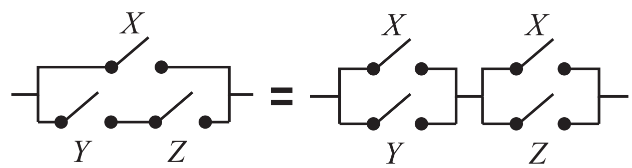
Unit 2 Problem Solutions

2.1 *See FLD p. 731 for solution.*

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 *Answer is in FLD p. 731*

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 Dist. Law
$= (ACD' + B)\,(ACD' + E)$ By Dist. Law
$= ACD' + BE$ By Dist. Law

2.5 (b) $(A' + B + C')\,(A' + C' + D)\,(B' + D')$
$= (A' + C' + BD)\,(B' + D')$
{By Distributive Law 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 Absorption}
$= X(W + Z)\,(W + Y)$

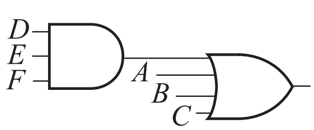
2.6 (c) $A'BC + EF + DEF' = A'BC + E(F + DF')$
$= A'BC + E(F + D) = (A'BC + E)\,(A'BC + F + D)$
$= (A' + E)\,(B + E)\,(C + E)\,(A' + F + D)$
$(B + F + D)\,(C + F + D)$

2.6 (d) $XYZ + W'Z + XQ'Z = Z(XY + W' + XQ')$
$= Z[W' + X(Y + Q')]$
$= Z(W' + X)\,(W' + Y + Q')$ By Distributive Law

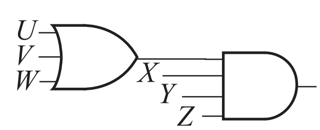
2.6 (e) $ACD' + C'D' + A'C = D'\,(AC + C') + A'C$
$= D'\,(A + C') + A'C$ By Elimination Theorem
$= (D' + A'C)\,(A + C' + A'C)$
$= (D' + A')\,(D' + C)\,(A + C' + A')$
By Distributive Law and Elimination Theorem
$= (A' + D')\,(C + D')$

2.6 (f) $A + BC + DE$
$= (A + BC + D)(A + BC + E)$
$= (A + B + D)(A + C + D)(A + B + E)(A + C + E)$

2.7 (a) $(\underline{A + B + C} + D)\,(\underline{A + B + C} + E)\,(\underline{A + B + C} + F)$
$= \underline{A + B + C} + DEF$
Apply second Distributive Law twice



2.7 (b) $W\underline{XYZ} + V\underline{XYZ} + U\underline{XYZ} = \underline{XYZ}\,(W + V + U)$
By first Distributive Law



2.8 (a) $[(AB)' + C'D]' = AB(C'D)' = AB(C + D')$
$= ABC + ABD'$

2.8 (b) $[A + B\,(C' + D)]' = A'(B(C' + D))'$
$= A'(B' + (C' + D)') = A'(B' + CD')$
$= A'B' + A'CD'$

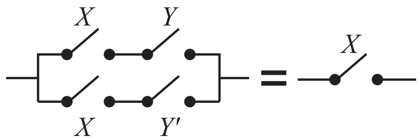
2.8 (c) $((A + B')\,C)'\,(A + B)\,(C + A)'$
$= (A'B + C')\,(A + B)C'A' = (A'B + C')A'BC'$
$= A'BC'$

2.9 (a) $F = [(A + B)' + (A + (A + B)')']\,(A + (A + B)')'$
$= (A + (A + B)')'$
By Elimination Theorem with
$X = (A + (A + B)')' = A'(A + B) = A'B$

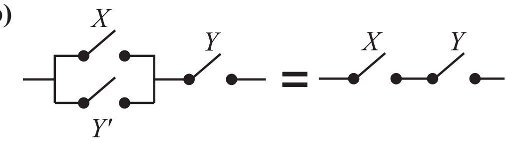
2.9 (b) $G = \{[(R + S + T)'\,PT(R + S)']'\,T\}'$
$= (R + S + T)'\,PT(R + S)' + T'$
$= T' + (R'S'T')\,P(R'S')T = T' + PR'S'T'T = T'$

Unit 2 Solutions

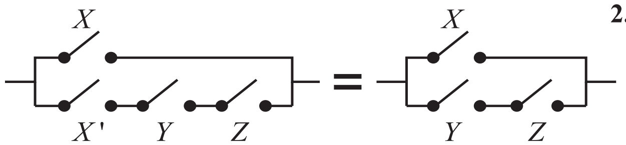
2.10 (a)



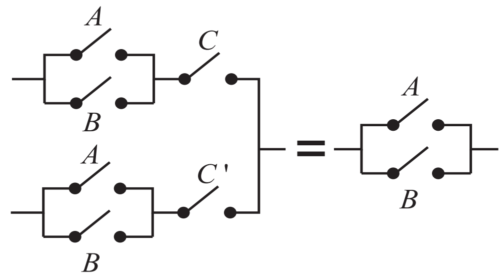
2.10 (b)



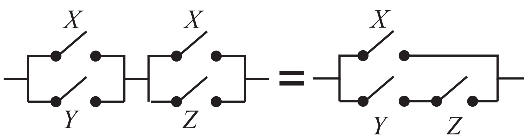
2.10 (c)



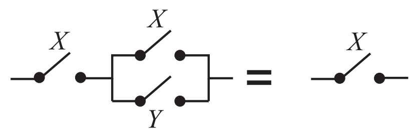
2.10 (d)



2.10 (e)



2.10 (f)



2.11 (a) $(A' + B' + C)(A' + B' + C)' = 0$ By Complementarity Law

2.11 (b) $AB(C' + D) + B(C' + D) = B(C' + D)$ By Absorption

2.11 (c) $AB + (C' + D)(AB)' = AB + C' + D$ By Elimination Theorem

2.11 (d) $(A'BF + CD')(A'BF + CEG) = A'BF + CD'EG$ By Distributive Law

2.11 (e) $[AB' + (C + D)' + E'F](C + D)$
$= AB'(C + D) + E'F(C + D)$ Distributive Law

2.11 (f) $A'(B + C)(D'E + F)' + (D'E + F)$
$= A'(B + C) + D'E + F$ By Elimination

2.12 (a) $(X + Y'Z) + (X + Y'Z)' = 1$ By Complementarity Law

2.12 (b) $[W + X'(Y + Z)][W' + X'(Y + Z)] = X'(Y + Z)$ By Uniting Theorem

2.12 (c) $(V'W + UX)'(UX + Y + Z + V'W) = (V'W + UX)'(Y + Z)$ By Elimination Theorem

2.12 (d) $(UV' + W'X)(UV' + W'X + Y'Z) = UV' + W'X$ By Absorption Theorem

2.12 (e) $(W' + X)(Y + Z') + (W' + X)'(Y + Z')$
$= (Y + Z')$ By Uniting Theorem

2.12 (f) $(V' + U + W)[(W + X) + Y + UZ'] + [(W + X) + UZ' + Y] = (W + X) + UZ' + Y$ By Absorption

2.13 (a) $F_1 = A'A + B + (B + B) = 0 + B + B = B$

2.13 (b) $F_2 = A'A' + AB' = A' + AB' = A' + B'$

2.13 (c) $F_3 = [(AB + C)'D][(AB + C) + D]$
$= (AB + C)'D\,(AB + C) + (AB + C)'D$
$= (AB + C)'D$ By Absorption

2.13 (d) $Z = [(A + B)C]' + (A + B)CD = [(A + B)C]' + D$
By Elimination with $X = [(A + B)C]'$
$= A'B' + C' + D'$

2.14 (a) $ACF(B + E + D)$

2.14 (b) $W + Y + Z + VUX$

2.15 (a) $f' = \{[A + (BCD)'][(AD)' + B(C' + A)]\}'$
$= [A + (BCD)']' + [(AD)' + B(C' + A)]'$
$= A'(BCD)'' + (AD)''[B(C' + A)]'$
$= A'BCD + AD[B' + (C' + A)']$
$= A'BCD + AD[B' + C''A']$
$= A'BCD + AD[B' + CA']$

2.15(b) $f' = [AB'C + (A' + B + D)(ABD' + B')]'$
$= (AB'C)'[(A' + B + D)(ABD' + B')]'$
$= (A' + B'' + C')[(A' + B + D)' + (ABD')'B'']$
$= (A' + B + C')[A''B'D' + (A' + B' + D'')B]$
$= (A' + B + C')[AB'D' + (A' + B' + D)B]$

2.16 (a) $f^D = [A + (BCD)'][(AD)' + B(C' + A)]^D$
$= [A(B + C + D)'] + [(A + D)'(B + C'A)]$

2.16 (b) $f^D = [AB'C + (A' + B + D)(ABD' + B')]^D$
$= (A + B' + C)[A'BD + (A + B + D')B')$

2.17 (a) $f = [(A' + B)C] + [A(B + C')]$
$= A'C + B'C + AB + AC'$
$= A'C + B'C + AB + AC' + BC$
$= A'C + C + AB + AC' = C + AB + A = C + A$

2.17 (b) $f = A'C + B'C + AB + AC' = A + C$

2.17 (c) $f = (A' + B' + A)(A + C)(A' + B' + C' + B)(B + C + C') = (A + C)$

2.18 (a) product term, sum-of-products, product-of-sums)

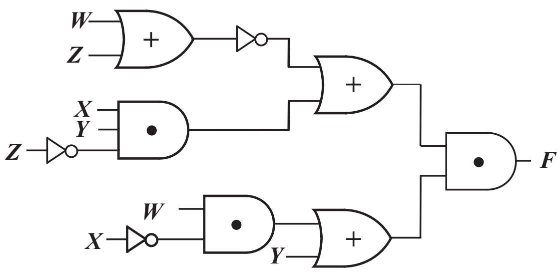
2.18 (b) sum-of-products

2.18 (c) none apply

2.18 (d) sum term, sum-of-products, product-of-sums

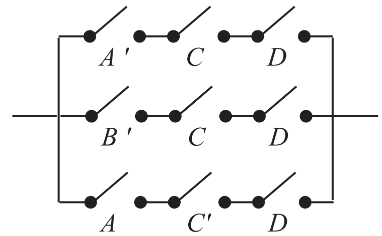
2.18 (e) product-of-sums

2.19

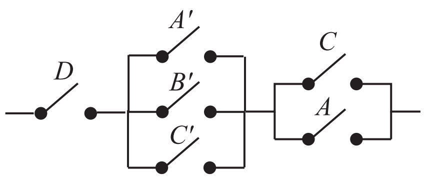


2.20 (a) $F = D[(A' + B')C + AC']$

2.20 (b) $F = D[(A' + B')C + AC']$
$= A'CD + B'CD + AC'D$



2.20 (c) $F = D[(A' + B')C + AC']$
$= D(A' + B' + AC')(C + AC')$
$= D(A' + B' + C')(C + A)$



2.21

A	B	C	H	F	G
0	0	0	0	0	0
0	0	1	1	1	x
0	1	0	1	0	1
0	1	1	1	1	x
1	0	0	0	0	0
1	0	1	1	0	1
1	1	0	0	0	0
1	1	1	1	1	x

2.22 (a) $A'B' + A'CD + A'DE'$
$= A'(B' + CD + DE')$
$= A'[B' + D(C + E')]$
$= A'(B' + D)(B' + C + E')$

2.22 (d) $A'B' + (CD' + E) = A'B' + (C + E)(D' + E)$
$= (A'B' + C + E)(A'B' + D' + E)$
$= (A' + C + E)(B' + C + E)$
$(A' + D' + E)(B' + D' + E)$

2.22 (b) $H'I' + JK$
$= (H'I' + J)(H'I' + K)$
$= (H' + J)(I' + J)(H' + K)(I' + K)$

2.22 (e) $A'B'C + B'CD' + EF' = A'B'C + B'CD' + EF'$
$= B'C(A' + D') + EF'$
$= (B'C + EF')(A' + D' + EF')$
$= (B' + E)(B' + F')(C + E)(C + F')$
$(A' + D' + E)(A' + D' + F')$

2.22 (c) $A'BC + AB'C + CD'$
$= C(A'B + AB' + D')$
$= C[(A + B)(A' + B') + D']$
$= C(A + B + D')(A' + B' + D')$

2.22 (f) $WX'Y + W'X' + W'Y' = X'(WY + W') + W'Y'$
$= X'(W' + Y) + W'Y'$
$= (X' + W')(X' + Y')(W' + Y + W')(W' + Y + Y')$
$= (X' + W')(X' + Y')(W' + Y)$

2.23 (a) $W + U'YV = (W + U')(W + Y)(W + V)$

2.23 (b) $TW + UY' + V$
$= (T+U+Z)(T+Y'+V)(W+U+V)(W+Y'+V)$

2.23 (c) $A'B'C + B'CD' + B'E' = B'(A'C + CD' + E')$
$= B'[E' + C(A' + D')]$
$= B'(E' + C)(E' + A' + D')$

2.23 (d) $ABC + ADE' + ABF' = A(BC + DE' + BF')$
$= A[DE' + B(C + F')]$
$= A(DE' + B)(DE' + C + F')$
$= A(B + D)(B + E')(C + F' + D)(C + F' + E')$

Unit 2 Solutions

2.24 (a) $[(XY')' + (X' + Y)'Z] = X' + Y + (X' + Y)'Z$
$= X' + Y' + Z$ By Elimination Theorem with $X = (X' + Y)$

2.24 (b) $(X + (Y'(Z + W)')')' = X'Y'(Z + W)' = X'Y'Z'W'$

2.24 (c) $[(A' + B')' + (A'B'C)' + C'D]'$
$= (A' + B')A'B'C(C + D') = A'B'C$

2.24 (d) $(A + B)CD + (A + B)' = CD + (A + B)'$
{By Elimination Theorem with $X = (A + B)'$}
$= CD + A'B'$

2.25 (a) $F(P, Q, R, S)' = [(R' + PQ)S]' = R(P' + Q') + S'$
$= RP' + RQ' + S'$

2.25 (b) $F(W, X, Y, Z)' = [X + YZ(W + X')]'$
$= [X + X'YZ + WYZ]'$
$= [X + YZ + WYZ]' = [X + YZ]'$
$= X'Y' + X'Z'$

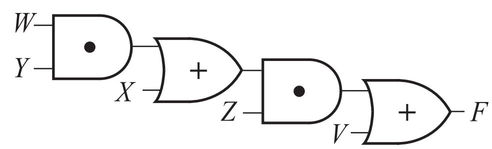
2.25 (c) $F(A, B, C, D)' = [A' + B' + ACD]'$
$= [A' + B' + CD]' = AB(C' + D')$

2.26 (a) $F = [(A' + B)'B]'C + B = [A' + B + B']C + B$
$= C + B$

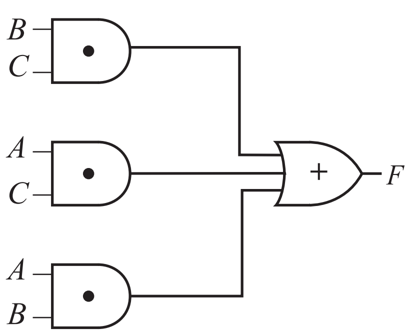
2.26 (b) $G = [(AB)'(B + C)]'C = (AB + B'C')C = ABC$

2.26 (c) $H = [W'X'(Y' + Z')]' = W + X + YZ$

2.27 $F = (\underline{V + X} + W)(\underline{V + X} + Y)(V + Z)$
$= (V + X + WY)(V + Z) = V + Z(X + WY)$
By Distributive Law with $X = V$

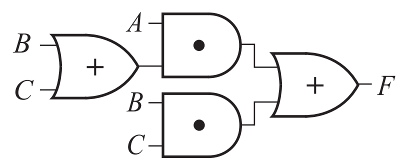


2.28 (a) $F = ABC + A'BC + AB'C + ABC'$
$= BC + AB'C + ABC'$ (By Uniting Theorem)
$= C(B + AB') + ABC' = C(A + B) + ABC'$
(By Elimination Theorem)
$= AC + BC + ABC' = AC + B(C + AC')$
$= AC + B(A + C) = AC + AB + BC$



2.28 (b) Beginning with the answer to (a):

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



Alternate solutions:

$F = AB + C(A + B)$

$F = AC + B(A + C)$

2.29 (a)

X Y Z	X+Y	X′+Z	(X+Y)(X′+Z)	XZ	X′Y	XZ+X′Y
0 0 0	0	1	0	0	0	0
0 0 1	0	1	0	0	0	0
0 1 0	1	1	1	0	1	1
0 1 1	1	1	1	0	1	1
1 0 0	1	0	0	0	0	0
1 0 1	1	1	1	1	0	1
1 1 0	1	0	0	0	0	0
1 1 1	1	1	1	1	0	1

2.29 (b)

X Y Z	X+Y	Y+Z	X′+Z	(X+Y)(Y+Z)(X′+Z)	(X+Y)(X′+Z)
0 0 0	0	0	1	0	0
0 0 1	0	1	1	0	0
0 1 0	1	1	1	1	1
0 1 1	1	1	1	1	1
1 0 0	1	0	0	0	0
1 0 1	1	1	1	1	1
1 1 0	1	1	0	0	0
1 1 1	1	1	1	1	1

Unit 2 Solutions

2-29 (c)

XYZ	XY	YZ	$X'Z$	$XY+YZ+X'Z$	$XY+X'Z$
0 0 0	0	0	0	0	0
0 0 1	0	0	1	1	1
0 1 0	0	0	0	0	0
0 1 1	0	1	1	1	1
1 0 0	0	0	0	0	0
1 0 1	0	0	0	0	0
1 1 0	1	0	0	1	1
1 1 1	1	1	0	1	1

2.29 (d)

ABC	$A+C$	$AB+C'$	$(A+C)(AB+C')$	AB	AC'	$AB+AC'$
0 0 0	0	1	0	0	0	0
0 0 1	1	0	0	0	0	0
0 1 0	0	1	0	0	0	0
0 1 1	1	0	0	0	0	0
1 0 0	1	1	1	0	1	1
1 0 1	1	0	0	0	0	0
1 1 0	1	1	1	1	1	1
1 1 1	1	1	1	1	0	1

2.29 (e)

$WXYZ$	$W'XY$	WZ	$W'XY+WZ$	$W'+Z$	$W+XY$	$(W'+Z)(W+XY)$
0 0 0 0	0	0	0	1	0	0
0 0 0 1	0	0	0	1	0	0
0 0 1 0	0	0	0	1	0	0
0 0 1 1	0	0	0	1	0	0
0 1 0 0	0	0	0	1	0	0
0 1 0 1	0	0	0	1	0	0
0 1 1 0	1	0	1	1	1	1
0 1 1 1	1	0	1	1	1	1
1 0 0 0	0	0	0	0	1	0
1 0 0 1	0	1	1	1	1	1
1 0 1 0	0	0	0	0	1	0
1 0 1 1	0	1	1	1	1	1
1 1 0 0	0	0	0	0	1	0
1 1 0 1	0	1	1	1	1	1
1 1 1 0	0	0	0	0	1	0
1 1 1 1	0	1	1	1	1	1

2.30

$F = (X+Y')Z + X'YZ'$ (from the circuit)
$= (X+Y'+X'YZ')(Z+X'YZ')$ (Distributive Law)
$= (X+Y'+X')(X+Y'+Y)(X+Y'+Z')(Z+X')(Z+Y)(Z+Z')$ (Distributive Law)
$= (1+Y')(X+1)(X+Y'+Z')(Z+X')(Z+Y)(1)$ (Complementation Laws)
$= (1)(1)(X+Y'+Z')(Z+X')(Z+Y)(1)$ (Operations with 0 and 1)
$= (X+Y'+Z')(Z+X')(Z+Y)$ (Operations with 0 and 1)

$G = (X+Y'+Z')(X'+Z)(Y+Z)$ (from the circuit)

Unit 2 Solutions