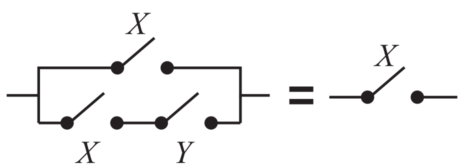
# ***Fundamentals of Logic Design Enhanced Edition 7th edition Roth Solutions Manual***

SKU: 9781337620352-SOLUTIONS

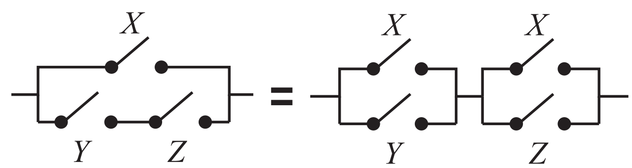
# Unit 2 Problem Solutions

**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}
$= X(W + Z)\,(W + Y)$

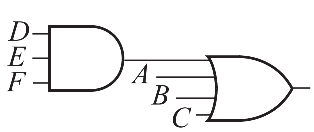
**2.6 (c)** $A'BC + EF + DEF' = A'BC + E(F + DF')$
$= A'BC + E(F + D) = (A'BC + E)\,(A'BC + F + D)$
$= (A' + E)\,(B + E)\,(C + E)\,(A' + F + D)$
$(B + F + D)\,(C + F + D)$

**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

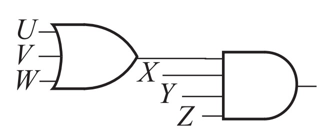
**2.6 (e)** $ACD' + C'D' + A'C = D'\,(AC + C') + A'C$
$= D'\,(A + C') + A'C$ By Elimination Theorem
$= (D' + A'C)\,(A + C' + A'C)$
$= (D' + A')\,(D' + C)\,(A + C' + A')$
By Distributive Law and Elimination Theorem
$= (A' + D')\,(C + D')$

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

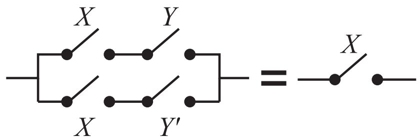
**2.8 (c)** $((A + B')\,C)'\,(A + B)\,(C + A)'$
$= (A'B + C')\,(A + B)C'A' = (A'B + C')A'BC'$
$= A'BC'$

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

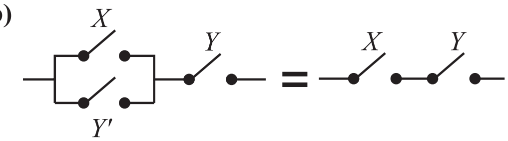
**2.9 (b)** $G = \{[(R + S + T)'\,PT(R + S)']'\,T\}'$
$= (R + S + T)'\,PT(R + S)' + T'$
$= T' + (R'S'T')\,P(R'S')T = T' + PR'S'T'T = T'$

# Unit 2 Solutions

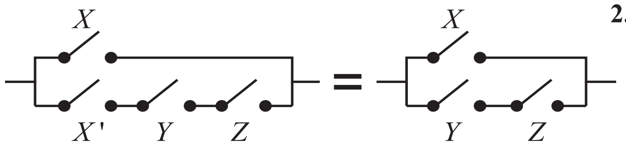
**2.10 (a)**



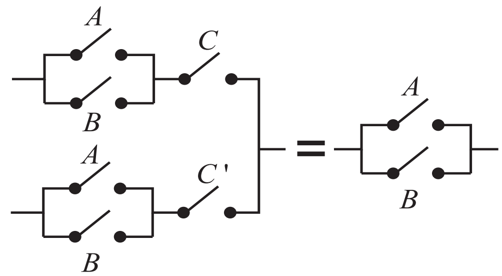

**2.10 (b)**



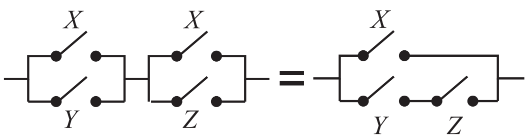

**2.10 (c)**



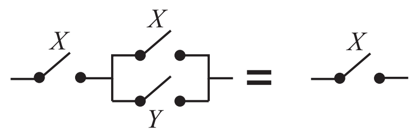

**2.10 (d)**




**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)

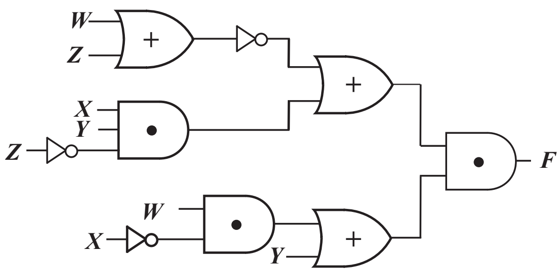
**2.18 (b)** sum-of-products

**2.18 (c)** none apply

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

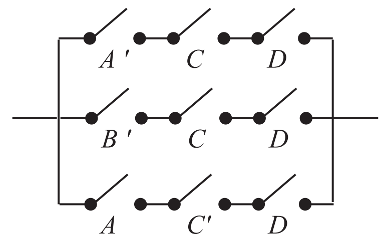
**2.18 (e)** product-of-sums

**2.19**

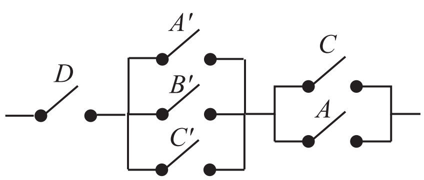



**2.20 (a)** $F = D[(A' + B')C + AC']$

**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)** $TW + UY' + V$
$= (T+U+V)(T+Y'+V)(W+U+V)(W+Y'+V)$

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

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

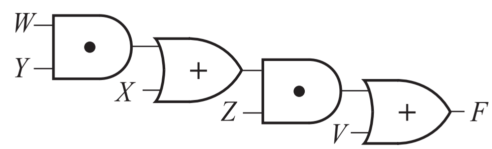
**2.25 (c)** $F(A, B, C, D)' = [A' + B' + ACD]'$
$= [A' + B' + CD]' = AB(C' + D')$

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

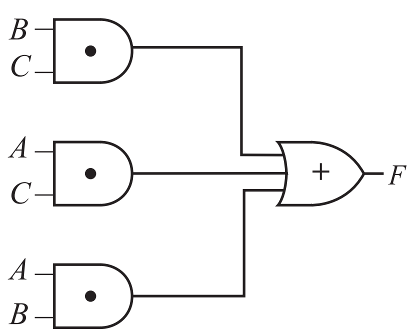
**2.26 (b)** $G = [(AB)'(B + C)]'C = (AB + B'C')C = ABC$

**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 $X = V$

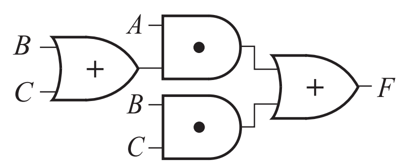



**2.28 (a)** $F = ABC + A'BC + AB'C + ABC'$
$= BC + AB'C + ABC'$ (By Uniting Theorem)
$= C\,(B + AB') + ABC' = C\,(A + B) + ABC'$
(By Elimination Theorem)
$= AC + BC + ABC' = AC + B\,(C + AC')$
$= AC + B\,(A + C) = AC + AB + BC$




**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)**

| $XYZ$ | $X+Y$ | $X'+Z$ | $(X+Y)(X'+Z)$ | $XZ$ | $X'Y$ | $XZ+X'Y$ |
|---|---|---|---|---|---|---|
| 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)**

| $XYZ$ | $X+Y$ | $Y+Z$ | $X'+Z$ | $(X+Y)(Y+Z)(X'+Z)$ | $(X+Y)(X'+Z)$ |
|---|---|---|---|---|---|
| 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 |

**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)