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Chapter 1 problems

1.1> a) 717.25_{10} 2 E 5 . 4

$$16\,)\,717$$
$$16\,)\,47 \cdots 5$$
$$2 \cdots 15$$

$.25 \times 16 = 4$ → $0010\ 1111\ 0101\ .\ 0100_{(2)}$

$2E5.4_{(16)}$

b) 123.17_{10}

$$16\,)\,123$$
$$7 \cdots 11$$

$0.17 \times 16 = 2.72$

$0.72 \times 16 = 11.52$ 7 B . 2 B 8 5 1 $2_{(16)}$

$0.52 \times 16 = 8.32$ → $0111\ 1011\ .\ 0010\ 1011\ 1000\ 0101\ 0001\ 0010_{(2)}$

$0.32 \times 16 = 5.12$

$0.12 \times 16 = 1.92$

$0.92 \times 16 = 14.72$

⋮

$7B.2B851E_{(16)}$

c) $356.89_{(10)}$

$$16\,)\,356$$
$$16\,)\,22 \cdots 4$$
$$1 \cdots 6$$

$0.89 \times 16 = 14.24$ $164.E3D70A_{(16)}$

$0.24 \times 16 = 3.84$ → $0001\ 0110\ 0100\ .\ 1111\ 0011\ 1011\ 0111\ 0000\ 1010_{(2)}$

$0.84 \times 16 = 13.44$

$164.E3D70A_{(16)}$

$0.44 \times 16 = 7.04$

$0.04 \times 16 = 0.64$

$0.64 \times 16 = 10.24$

⋮

d) $1063.5_{(10)}$

$$\begin{array}{r|l} 16 & 1063 \\ \hline 16 & 66 \cdots 7 \\ \hline & 4 \cdots 2 \end{array}$$

$0.5 \times 16 = 8$

$427.8_{(16)}$

$\rightarrow 0100\ 0010\ 0111\ .\ 1000_{(2)}$

$427.8_{(16)}$

1.4) a) $1457.11_{(10)}$

$$\begin{array}{r|l} 16 & 1457 \\ \hline 16 & 91 \cdots 1 \\ \hline & 5 \cdots 11 \end{array}$$

$0.11 \times 16 = 1.76$

$0.76 \times 16 = 12.16$

$5B1.1C_{(16)}$

b) $5\ B\ 1.\ 1C_{(16)} = 0101\ 1011\ 0001.\ 0001\ 1100_{(2)}$

$= 010\ 110\ 110\ 001.\ 000\ 111\ 00_{(2)}$

$= 2661.070_{(8)}$

c) When converting hexadecimal directly to binary. we form groups of 4 bits. $(2^4=16)$ So, if we want to convert directly to base 4 we have to form groups of 2bits. $(4^2=16)$

5 B 1 . 1 C

$= 0101\ 1011\ 0001.\ 0001\ 1100_{(2)}$

$= 01\ 01\ 10\ 11\ 00\ 01.\ 00\ 01\ 11\ 00_{(2)}$

$= 1\ 1\ 2\ 3\ 0\ 1.\ 0\ 1\ 3\ 0_{(4)}$

1.7) a)

$$\begin{array}{rr} & 21 \\ + & 11 \\ \hline & 32 \end{array} \neq \begin{array}{r} 010101 \\ 001011 \\ \hline 100000 \end{array}$$

$= (-32_{10})$

overflow has occured

b)

$$\begin{array}{rr} & -14 \\ + & -32 \\ \hline & -46 \end{array} \neq \begin{array}{r} 110010 \\ 100000 \\ \hline 010010 \end{array}$$

$(= 18)$

Overflow occured

c)

$$\begin{array}{rr} & -25 \\ + & 18 \\ \hline & -7 \end{array} = \begin{array}{r} 100111 \\ 010010 \\ \hline 111001 \end{array}$$

$(= -7)$

no overflow

d)

$$\begin{array}{rr} & -12 \\ + & 13 \\ \hline & 1 \end{array} = \begin{array}{r} 110100 \\ 001101 \\ \hline 000001 \end{array}$$

no overflow

e)

$$\begin{array}{rr} & -11 \\ + & -21 \\ \hline & -32 \end{array} = \begin{array}{r} 110101 \\ 101011 \\ \hline 100000 \end{array}$$

no overflow

· Repeat (a) (c) (d) (e) using 1's complement

a)

$$\begin{array}{rr} & 21 \\ + & 11 \\ \hline & 32 \end{array} \quad \begin{array}{r} 010101 \\ 001011 \\ \hline 100000 \end{array}$$

Sign bit of the result is different with sign bit of numbers. overflow occured

c)

$$\begin{array}{rr} & -25 \\ + & 18 \\ \hline & -7 \end{array} \quad \begin{array}{r} 100110 \\ 010010 \\ \hline 111000 \end{array}$$

Sign bit of both numbers is different → no overflow d)

$$\begin{array}{rr} & -12 \\ + & 13 \\ \hline & 1 \end{array} \qquad \begin{array}{r} 110011 \\ 001101 \\ \hline (1)\,000000 \\ 1 \\ \hline 000001 \end{array}$$

no overflow

e)

$$\begin{array}{r} -11 \\ -12 \\ \hline -23 \end{array} \qquad \begin{array}{r} 110100 \\ 101010 \\ \hline (1)\,011110 \\ 1 \\ \hline 011111 \end{array}$$

sign bit has changed in result

→ overflow occured

1.12> a) $375.54_{(8)}$

$= 3\times 8^2 + 7\times 8 + 5\times 1 + 5\times\frac{1}{8} + 4\times\frac{1}{8^2}$

$= 253.6875_{(10)}$

$$\begin{array}{l} 3\,)\,253 \\ 3\,)\,84 \cdots 1 \\ 3\,)\,28 \cdots 0 \\ 3\,)\,9 \cdots 1 \\ 3\,)\,3 \cdots 0 \\ \quad 1 \cdots 0 \end{array}$$

$0.6875\times 3 = 2.0625$
$0.0625\times 3 = 0.1875$
$0.1875\times 3 = 0.5625$
$0.5625\times 3 = 1.6875$

$100101.20012001\cdots_{(3)}$

b) 384.74_{10}

$$\begin{array}{l} 4\,)\,384 \\ 4\,)\,96 \cdots 0 \\ 4\,)\,24 \cdots 0 \\ 4\,)\,6 \cdots 0 \\ \quad 1 \cdots 2 \end{array}$$

$0.74\times 4 = 2.96$
$0.96\times 4 = 3.84$
$0.84\times 4 = 3.36$
$0.36\times 4 = 1.44$
$\vdots$

$12000.2331_{(4)}$

1.16> b) $93.70_{(10)}$

$$\begin{array}{l} 8\,)\,93 \\ 8\,)\,11 \cdots 5 \\ \quad 1 \cdots 3 \end{array}$$

$0.7\times 8 = 5.6$
$0.6\times 8 = 4.8$
$0.8\times 8 = 6.4$
$0.4\times 8 = 3.2$
$0.2\times 8 = 1.6$

$135.54631_{(8)}$

$001\ 011\ 101.101\ 100\ 110\ 011\ 001_{(2)}$

d) $109.30_{(10)}$

$$\begin{array}{l} 8\,)\,109 \\ 8\,)\,13 \cdots 5 \\ \quad 1 \cdots 5 \end{array}$$

$0.3\times 8 = 2.4$
$0.4\times 8 = 3.2$
$0.2\times 8 = 1.6$
$0.6\times 8 = 4.8$
$0.8\times 8 = 6.4$

$155.23146_{(8)}$

$= 001\ 101\ 101.010\ 011\ 001\ 100\ 110_{(2)}$

1.18) a)

$$\begin{array}{r} 10100100 \\ -\ 01110011 \\ \hline 00110001 \end{array}$$

1.20) a)

$$\begin{array}{r} 10111 \\ 110\ \overline{)\ 10001101} \\ 110 \\ \hline 101 \\ 0 \\ \hline 1011 \\ 110 \\ \hline 1010 \\ 110 \\ \hline 1001 \\ 110 \\ \hline \underline{\underline{0011}} \end{array}$$

check

$$\begin{array}{r} 10111 \\ 110 \\ \hline 00000 \\ 10111 \\ 10111 \\ \hline 10001010 \\ 11\ + \\ \hline 10001101 \end{array}$$

(correct)

1.31) a) $-11010_2 = 100101_2$

$$\begin{array}{r} 001001 \\ +\ 100101 \\ \hline 101110_2 \end{array}$$

Sign bits of two numbers are different, so no overflow occurs.

b) $-11001_2 = 100110_2$

$$\begin{array}{r} 011010 \\ +\ 100110 \\ \hline (1)\ 000000 \\ 1 \\ \hline 000001 \end{array}$$

Sign bits of two numbers are different, so no overflow occurs

c) $-01101_2 = 110010_2$

$$\begin{array}{r} 010110 \\ +\ 110010 \\ \hline (1)\,001000 \\ 1 \\ \hline 001001 \end{array}$$

no overflow

d) $-00111_2 = 111000_2$

$$\begin{array}{r} 011011 \\ +\ 111000 \\ \hline (1)\,010011 \\ 1 \\ \hline 010100 \end{array}$$

no overflow

· Repeat using 2's complement

a) $-11010 = 100101 + 1 = 100110$

$$\begin{array}{r} 001001 \\ +\ 100110 \\ \hline 101111 \end{array}$$

no overflow

b) $-11001_2 = 100111_2$

$$\begin{array}{r} 011010 \\ +\ 100111 \\ \hline 000001 \end{array}$$

no overflow

c) $-01101_2 = 110011_2$

$$\begin{array}{r} 010110 \\ 110011 \\ \hline 001001 \end{array}$$

no overflow

d) $-00111 = 111001$

$$\begin{array}{r} 011011 \\ +\ 111001 \\ \hline 010100 \end{array}$$

no overflow

e) $-10101_2 = 101011_2$

$$\begin{array}{r} 011100 \\ +\ 101011 \\ \hline 000111 \end{array}$$

no overflow

Chapter 2 problems

2.5) a) $\underline{(A+B)(C+B)(D'+B)}(ACD'+E)$

$= (ACD'+B)(ACD'+E) = ACD'+BE$

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

b) $WX+WY'X+ZYX = WX(1+Y')+ZYX = WX+ZYX$

$= X(W+ZY) = X(W+Z)(W+Y)$

c) $A'BC+EF+DEF' = A'BC+E(F+DF') = A'BC+E(D+F)$

$= (A'BC+E)(A'BC+D+F) = (A'+E)(B+E)(C+E)(A'+D+F)(B+D+F)(C+D+F)$

d) $XYZ+W'Z+XQ'Z = Z(XY+W'+XQ') = Z(X(Y+Q')+W')$

$= Z(W'+X)(W'+Y+Q')$

e) $ACD'+C'D'+A'C = C(AD'+A')+C'D' = C(A'+D')+C'D'$

$= CA'+CD'+C'D' = CA'+D'(C+C') = CA'+D' = (C+D')(A'+D')$

f) $A+BC+DE = (A+BC+D)(A+BC+E)$

$= (A+D+B)(A+D+C)(A+E+B)(A+E+C)$

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

(b) $[A+B(C'+D)]' = (A+BC'+BD)' = A'(B'+C)(B'+D') = A'(B'+CD')$

$= A'B'+A'CD'$

(c) $((A+B')C)'(A+B)(C+A)' = (A'B+C')(A+B)C'A' = (A'B+C')(C'AA'+A'BC')$

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

2.5) b)가 누락되어 추가합니다

2.5) b) $(A'+B+C')(A'+C'+D)(B'+D')$

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

$$= A'B'+A'D'+B'C'+C'D'+\cancel{BD(B'+D')}$$

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

2.11) a) $(A'+B'+C)(A'+B'+C)' = 0$ $\quad (X \cdot X' = 0)$

b) $AB(C'+D) + B(C'+D) = B(C'+D)$ $\quad (XY + X = X)$

c) $AB + C(C'+D)(AB)' = AB + C'+D$ $\quad (X + YX' = X+Y)$

d) $(A'BF + CD')(A'BF + CEG) = A'BF + CD'EG$ $\quad (X+Y)(X+Z) = X+YZ$

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

$= AB'C + AB'D + E'CF + E'DF$ $\quad (X \cdot X' = 0)$

f) $A'(B+C)(D'E+F')' + (D'E+F) = D'E + F + A'B + A'C$ $\quad (X+YX' = X+Y)$

2.12) a) $(X+Y'Z) + (X+Y'Z)' = 1$ $\quad (X+X' = 1)$

b) $[W + X'(Y+Z)][W' + X'(Y+Z)] = X'Y + X'Z$ $\quad ((X+Y)(X'+Y) = Y)$

c) $(V'W+UX)'(UX+Y+Z+V'W)$ $\quad$ De Morgan's law

$= (V'W+UX)'(V'W+UX) + (V'W+UX)'(Y+Z) = (V+W')(U'+X')(Y+Z)$

d) $(UV'+W'X)(UV'+W'X+Y'Z) = UV'+W'X$ $\quad (X(X+Y) = X)$

e) $(W'+X)(Y+Z') + (W'+X)'(Y+Z') = Y+Z'$ $\quad (XY + X'Y = Y)$

f) $(V'+U+W)[(W+X)+Y+UZ'] + [(W+X)+UZ'+Y]$ $\quad (X+XY = X)$

$= (W+X) + UZ' + Y$

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

$= A'(BCD) + AD(B'+CA') = A'BCD + AB'D$

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

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

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

2.16) a) Divide f into two segments.

$S_1 = [A+(BCD)']$ $S_1^D = [A+(BCD)']^D = A(B+C+D)'$

$S_2 = [(AD)'+B(C'+A)]$ $S_2^D = [(AD)'+B(C'+A)]^D = (A+D)'(B+C'A)$

$\therefore f^D = A(B+C+D)' + (A+D)'(B+C'A)$

b) Divide f into two segments

$S_1 = AB'C$ $S_1^D = A+B'+C$

$S_2 = (A'+B+D)(ABD'+B')$ $S_2^D = (A'+B+D)(ABD'+B')^D$

$= A'BD + (A+B+D')B'$

$f^D = (A+B'+C)[A'BD + (A+B+D')B'$

Chapter 3 problems

3.6) a) $(W+X'+Z')(W'+Y')(W'+X+Z')(W+X')(W+Y+Z)$

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

$= [W+X'(Y+Z)][W'+Y'(X+Z')] = (W+X'Y+X'Z)(W'+XY'+Y'Z')$

$= W(XY'+Y'Z') + W'(X'Y+X'Z) = WXY'+WY'Z'+W'X'Y+W'X'Z$

b) $(A+B+C+D)(A'+B'+C+D')(A'+C)(A+D)(B+C+D)$

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

$= ABC+A'BD+AC+A'CD+ACD+A'D$

$= AC+A'D+A'BD+ACD = AC+A'D$

3.7) a) $BCD+C'D'+B'C'D+CD = CD(B+1)+C'D'+B'C'D$

$= CD+C'D'+B'C'D = D(C+B'C')+C'D' = D(C+B')(C+C')+C'D'$

$= D(C+B')+C'D' = (DC+DB'+C')(DC+DB'+D')$

$= (D+C'+DB')(D'+C+DB') = (D+C')(C+B'+D')$

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

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

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

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

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

3.10) a) $$(X+W)(Y \oplus Z)+XW' = (X+W)(Y'Z+YZ')+XW'$$

$$= \cancel{XY'Z} + \cancel{XYZ'} + WY'Z + WYZ' + XW'$$

$$= XY'Z + WYZ' + XW'$$

3.14) a) $$K'L'M + KM'N + KLM + LM'N'$$

$$= M(K'L'+KL) + M'(KN+LN') = (M+KN+LN')(M'+K'L'+KL)$$

$$= (M+(K+N')(N+L))(M'+(K'+L)(L'+K))$$

$$= (M+K+N')(M+N+L)(M'+K'+L)(M'+L'+K)$$

b) $$KL + K'L' + L'M'N' + LMN' = L(K+MN') + L'(K'+M'N')$$

$$= (L+K'+M'N')(L'+K+MN')$$

$$= (L+K'+M')(L+K'+N')(L'+K+M)(L'+K+N')$$

c) $$KL + K'L'M + L'M'N + LM'N'$$

$$= L(K+M'N') + L'(K'M+M'N)$$

$$= (L+K'M+M'N)(L'+K+M'N')$$

$$= (L+(M+N)(M'+K'))(L'+K+M')(L'+K+N')$$

$$= (L+M+N)(L+M'+K')(L'+K+M')(L'+K+N')$$

d) $$K'M'N + KL'N' + K'MN' + LN = N(K'M'+L) + N'(KL'+K'M)$$

$$= N(L+K')(L+M') + N'(K+M)(K'+L') = (N+(K+M)(K'+L'))(N'+(L+K')(L+M'))$$

$$= (N+K+M)(N+K'+L')(N'+L+K')(N'+L+M')$$

e) $WXY+WX'Y+WYZ+XYZ' = Y(WX+WX'+WZ+XZ')$

$= Y(W(X+X'+Z)+XZ') = Y(W+XZ') = Y(W+X)(W+Z')$

3.15> a) $(K'+M'+N)(K'+M)(L+M'+N')(K'+L+M)(M+N)$

$= (K'+M(M'+N))(L+(M'+N')(K'+M))(M+N)$

$= (K'+MN)(M+N)(L+(M'+N')(K'+M))$

$= (K'M+K'N+MN)(L+M'K'+N'K'+N'M)$

$= \cancel{LK'M} + MN'K' + K'M'N + \cancel{K'LN} + MNL$

$= MN'K' + K'M'N + MNL$

3.19> a) $x+y = x \oplus y \oplus xy$

$x \oplus y \oplus xy = (x'y+xy') \oplus xy = (x'y+xy')'xy + (x'y+xy')(xy)'$

$= (x+y')(x'+y)xy + (x'y+xy')(x'+y')$

$= (xy+x'y')xy + x'y + xy' = xy + x'y + xy' = y(x+x') + xy' = y + xy' = (y+x)(y+y') = y+x$

$\therefore x+y = x \oplus y \oplus xy$

b) $x+y = x \equiv y \equiv xy$

$x \equiv y \equiv xy = (xy+x'y') \equiv xy = (xy+x'y')xy + (xy+x'y')'(xy)'$

$= xy + (x'+y')(x+y)(x'+y') = xy + x'y + y'x = x(y+y') + x'y = x + x'y$

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

$\therefore x+y = x \equiv y \equiv xy$

3.21) a) $\cancel{BC'D'} + ABC' + \cancel{AC'D} + AB'D + A'BD'$

$= ABC' + AB'D + A'BD'$

b) $W'Y' + \cancel{WYZ} + \cancel{XY'Z} + WX'Y + WXZ$

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

3.25) f) $A'BCD + A'BC'D + B'EF + CDE'G + A'DEF + A'B'EF$

$= A'BD(C+C') + B'EF(1+A') + CDE'G + A'DEF$

$= A'BD + B'EF + CDE'G + \cancel{A'DEF} = A'BD + B'EF + CDE'G$

g) $[(a'+d'+b'c)(b+d+ac')]' + b'c'd' + a'c'd$

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

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

$= abd + ac'd + a'b'd' + b'cd' + b'c'd' + a'c'd$

$= abd + ac'd + a'b'd' + b'd' + a'c'd$

$= abd + a'b'd' + b'd' + c'd = abd + b'd' + c'd$

3.26) a) $A'C'D' + AC' + BCD + A'CD' + A'BC + AB'C'$

$= A'D' + AC' + BCD + \cancel{A'BC} = A'D' + AC' + BCD$

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

$= B'C' + A'C + ABD + \cancel{AC'D} = B'C' + A'C + ABD$