Digital engineering 1st report solutions

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1.10(a)	1.10(b)
1305.375_{10} $16 \mid 1305$ 0.375 $16 \mid 81$ r9 $\times 16$ 5 r1 (6).000 $\therefore 1305.375_{10} = 519.600_{16}$ $= 0101\ 0001\ 1001.0110\ 0000\ 0000_2$ 5 1 9 6 0 0	Thus, the hexadecimal equivalent of 111.33_{10} is $6F.547AE1_{16}$. Convert $6F.547AE1_{16}$ to its binary equivalent. 6 F . 5 4 7 A E 1_{16} 0110 1111 . 0101 0100 0111 1010 1110 0001_2 Thus, the binary equivalent of $6F.54_{16}$ is, $01101111.010101000111101011100001_2$.
1.10(c)	**1.10(d)**
301.12_{10} $16 \mid 301$ 0.12 $16 \mid 18$ r13 $\times 16$ 1 r2 (1).92 $\times 16$ (14).72 $\therefore 301.12_{10} = 12D.1E_{16}$ $= 0001\ 0010\ 1101.0001\ 1110_2$ 1 2 D 1 E	1644.875_{10} $16 \mid 1644$ 0.875 $16 \mid 102$ r12 $\times 16$ 6 r6 (14).000 $\therefore 1644.875_{10} = 66C.E00_{16}$ $= 0110\ 0110\ 1100.1110\ 0000\ 0000_2$ 6 6 C E 0 0
1.17(a)	**1.17(b)**
111 (carries) 1111 (Add) 1001 11000 111 (borrows) 1111 (Subtract) 1001 0110 1111 (Multiply) 1001 1111 0000 01111 0000 001111 1111 10000111	1 (carry) 1101001(Add) 110110 10011111 11 11 (borrows) 1101001 (Sub) 110110 110011 1101001 (Mult) 110110 0000000 1101001 11010010 1101001 1001110110 0000000 1001110110 1101001 100100000110 1101001 1011000100110

1.17(c)	1.37(a)
1 110010 (Add) 11101 1001111 111 1 110010 (Sub) 11101 10101 110010 (Mult) 11101 110010 000000 0110010 110010 11111010 110010 1010001010 110010 10110101010	01001-11010 In 2's complement 01001 + 00110 01111 In 1's complement 01001 + 00101 01110

1.37(b)	1.37 (c)
In 2's complement 11010 + 00111 (1)00001 In 1's complement 11010 + 00110 (1)00000 →1 00001	In 2's complement 10110 + 10011 (1)01001 *overflow* In 1's complement 10110 + 10010 (1)01000 →1 01001 *overflow*
1.37 (d)	**1.37 (e)**
In 2's complement 11011 + 11001 (1)10100 In 1's complement 11011 + 11000 (1)10011 →1 10100	In 2's complement 11100 + 01011 (1)00111 In 1's complement 11100 + 01010 (1)00110 →1 00111

2.12(a)

Write the expression for Boolean equation.

$$f=(X+YZ)+(X+YZ)'$$

Consider the law of complementarity.

$$A+A'=1$$

Let $A=(X+YZ)$.

Apply the law of complementarity to the Boolean equation.

$$\begin{aligned}f&=(X+YZ)+(X+YZ)'\\&=A+A'\\&=1\end{aligned}$$

Thus, the simplified expression for $(X+YZ)+(X+YZ)'$ is $\boxed{1}$.

2.12(b)

Write the expression for Boolean equation.

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

Consider the Uniting theorem.

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

Let,

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

Apply the Uniting theorem to the Boolean equation.

$$\begin{aligned}f&=[W+X'(Y+Z)][W'+X'(Y+Z)]\\&=(A+B)(A+B')\\&=A\\&=X'(Y+Z)\end{aligned}$$

Thus, the simplified expression for $[W+X'(Y+Z)][W'+X'(Y+Z)]$ is $\boxed{X'(Y+Z)}$.

2.12(c)

Write the expression for Boolean equation.

$$\begin{aligned}f&=(VW+UX)'(UX+Y+Z+VW)\\&=(VW+UX)'[(Y+Z)+(VW+UX)]\end{aligned}$$

Consider the Elimination theorem.

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

Let,

$$A=(Y+Z)$$
$$B=(VW+UX)'$$

Apply the Elimination theorem to the Boolean equation.

$$\begin{aligned}f&=(VW+UX)'[(Y+Z)+(VW+UX)]\\&=B(A+B')\\&=AB\\&=(Y+Z)(VW+UX)'\end{aligned}$$

Thus, the simplified expression for $(VW+UX)'(UX+Y+Z+VW)$ is,

$$\boxed{(Y+Z)(VW+UX)'}.$$

2.12(d)

Write the expression for Boolean equation.

$$f=(UV'+WX)(UV'+WX+YZ)$$

Consider the Absorption theorem.

$$A(A+B)=A$$

Let,

$$A=UV'+WX$$
$$B=YZ$$

Apply the Absorption theorem to the Boolean equation.

$$\begin{aligned}f&=(UV'+WX)(UV'+WX+YZ)\\&=A(A+B)\\&=A\\&=UV'+WX\end{aligned}$$

Thus, the simplified expression for $(UV'+WX)(UV'+WX+YZ)$ is $\boxed{UV'+WX}$.

2.12(e)	2.12(f)

2.12(e)

Write the expression for Boolean equation.

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

Consider the Uniting theorem.

$$AB + AB' = A$$

Let,

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

Apply the Uniting theorem to the Boolean equation.

$$\begin{aligned} f &= (W'+X)(Y+Z') + (W'+X)'(Y+Z') \\ &= AB + AB' \\ &= A \\ &= (Y+Z') \end{aligned}$$

Thus, the simplified expression for $(W'+X)(Y+Z') + (W'+X)'(Y+Z')$ is $\boxed{(Y+Z')}$.

2.12(f)

Write the expression for Boolean equation.

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

Consider the Absorption theorem.

$$A + AB = A$$

Let,

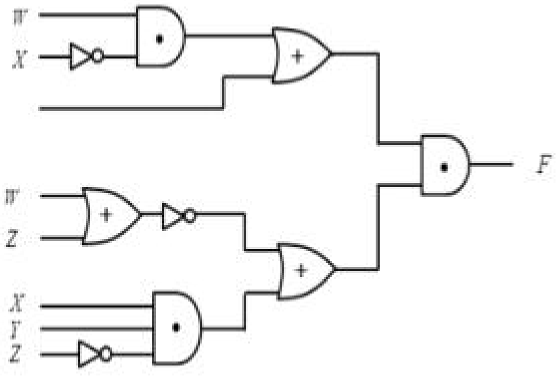
$$A = \left[(W+X)+UZ'+Y\right]$$
$$B = (V'+U+W)$$

Apply the Absorption theorem to the Boolean equation.

$$\begin{aligned} f &= (V'+U+W)\left[(W+X)+Y+UZ'\right] + \left[(W+X)+UZ'+Y\right] \\ &= A + AB \\ &= A \\ &= (W+X)+UZ'+Y \end{aligned}$$

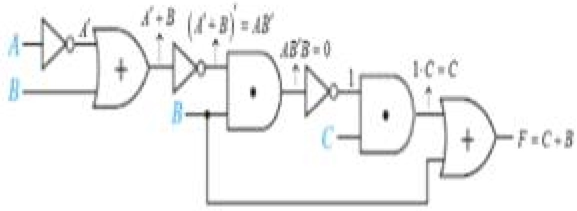
Thus, the simplified expression for $(V'+U+W)\left[(W+X)+Y+UZ'\right] + \left[(W+X)+UZ'+Y\right]$ is $\boxed{(W+X)+UZ'+Y}$.

2.19

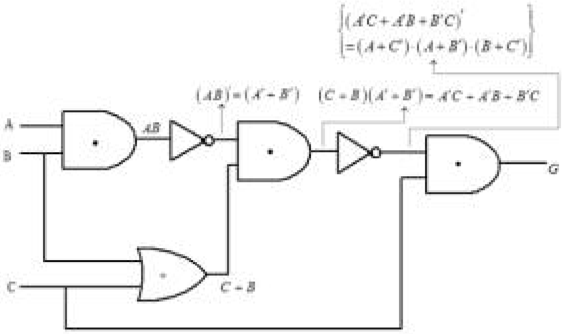
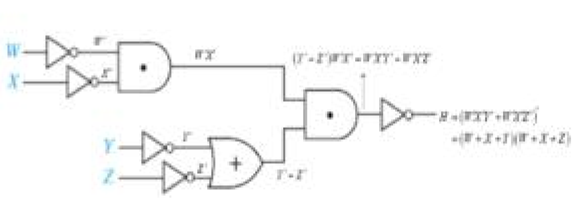


2.26(a)

Examine the circuit diagram.



Thus, Boolean expression of the circuit diagram is, $\boxed{F = C+B}$

2.26(b)	2.26(c)
Examine the circuit diagram.  The output Boolean expression is, $G=(A+C')\cdot(A+B')\cdot(B+C')\cdot C$ $=(AC+C'C)\cdot(AC+B'C)\cdot(BC+C'C)$ $=(AC)\cdot(BC)\cdot(AC+B'C)$ $=(ABC)\cdot(AC+B'C)$ $=ABC$ Thus, Boolean expression of the circuit diagram is, $\boxed{G=ABC}$.	Examine the circuit diagram.  The output Boolean expression becomes: $H=(W'X'Y'+W'X'Z')'$ $=(W+X+Y)(W+X+Z)$ $=W+WX+WZ+WX+X+XZ+YW+YX+YZ$ $=W(1+X+Z+X+Y)+X(1+Z+Y)+YZ$ $=W+X+YZ$ Thus, Boolean expression of the circuit diagram is, $\boxed{H=W+X+YZ}$.
3.13(a)	3.13(b)
Consider the following Boolean expression: $W=KLMN'+K'L'MN+MN'$ Simplify expression by using Boolean algebraic theorems: $W=MN'(KL+1)+K'L'MN$ $=MN'(1)+K'L'MN$ (Since $1+A=A$) $=M(N'+K'L'N)$ $=M(N'+K'L')(N'+N)$ (Since $A+BC=(A+B)(A+C)$) $=M(N'+K'L')(1)$ (Since $A+A'=1$) $=MN'+K'L'M$ Hence, the simplified Boolean expression is $\boxed{MN'+K'L'M}$.	Consider the following Boolean expression: $X=KL'M'+MN'+LM'N'$ Simplify expression by using Boolean algebraic theorems: $X=KL'M'+N'(M+LM')$ $=KL'M'+N'(M+L)(M+M')$ (Since $A+BC=(A+B)(A+C)$) $=KL'M'+N'(M+L)(1)$ (Since $A+A'=1$) $=KL'M'+MN'+LN'$ Hence, the simplified Boolean expression is $\boxed{KL'M'+MN'+LN'}$.

<table>
<tr><td></td><td></td></tr>
<tr><td>3.13(c)</td><td>3.13(d)</td></tr>
<tr><td>
Consider the following Boolean expression:
$Y=(K+L')(K'+L'+N)(L'+M+N')$
Simplify expression by using Boolean algebraic theorems:
$Y=(L'+K)\{L'+(K'+N)\}(L'+M+N')$
Assume, $A=L'$, $B=K$ and $C=K'+N$
$Y=\{L'+K(K'+N)\}(L'+M+N')$ (Since $(A+B)(A+C)=A+BC$)
$=(L'+KK'+KN)(L'+M+N')$
$=(L'+KN)\{L'+(M+N')\}$
Assume, $A=L'$, $B=KN$ and $C=M+N'$
$Y=\{L'+KN(M+N')\}$ (Since $(A+B)(A+C)=A+BC$)
$=L'+KMN+KNN'$
$=L'+KMN+K(0)$ (Since $AA'=0$)
$=L'+KMN$
Hence, the simplified Boolean expression is $\boxed{L'+KMN}$.
</td><td>
Consider the following Boolean expression:
$Z=(K'+L+M'+N)(K'+M'+N+R)(K'+M'+N+R')KM$
Simplify expression by using Boolean algebraic theorems:
$Z=\{(K'+M')+(L+N)\}\{(K'+M')+(N+R)\}\{(K'+M')+(N+R')\}KM$
Assume, $A=K'+M'$, $B=L+N$ and $C=N+R$
$Z=\{(K'+M')+(L+N)(N+R)\}\{(K'+M')+(N+R')\}KM$
(Since $(A+B)(A+C)=A+BC$)
Assume, $A=K'+M'$, $B=(L+N)(N+R)$ and $C=N+R'$
$Z=\{(K'+M')+(L+N)(N+R)(N+R')\}KM$
(Since $(A+B)(A+C)=A+BC$)
Assume, $A=N$, $B=L$ and $C=R$
$Z=\{(K'+M')+(N+LR)(N+R')\}KM$ (Since $(A+B)(A+C)=A+BC$)
Assume, $A=N$, $B=LR$ and $C=R'$
$Z=\{(K'+M')+(N+LRR')\}KM$ (Since $(A+B)(A+C)=A+BC$)
$=\{(K'+M')+(N+L(0))\}KM$ (Since $AA'=0$)
$=\{(K'+M')+N\}KM$
$=(K'+M'+N)KM$
$=KK'M+KMM'+KMN$
$=(0)M+K(0)+KMN$ (Since $AA'=0$)
$=KMN$
Hence, the simplified Boolean expression is $\boxed{KMN}$.
</td></tr>
</table>

3.19(a)	1.10(b)

3.19(a)

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

Consider R.H.S $x\oplus y\oplus xy$

The Equivalence of exclusive-OR is

$a\oplus b=a'b+ab'$

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

$\Rightarrow(x'y+xy')'(xy)+(x'y+xy')(xy)'$

Using DeMorgan's law,

$\Rightarrow(x'y)'(xy')'(xy)+(x'y+xy')(x'+y')\ \left[\because(a+b)'=a'\cdot b'\right]$

$\Rightarrow(x+y')(x'+y)(xy)+x'yx'+x'yy'+xy'x'+xy'y'\ \left[\because(ab)'=a'+b'\right]$

$\Rightarrow(x+y')(x'+y)(xy)+x'y+xy'\ \begin{bmatrix}\because a\cdot a=a\ ;\\ a\cdot a'=0\end{bmatrix}$

$\Rightarrow(xx'+xy+y'x'+y'y)(xy)+x'y+xy'$

$\Rightarrow(xy+y'x')(xy)+x'y+xy'\ [\because a\cdot a'=0]$

$\Rightarrow(xyxy+xyy'x')+x'y+xy'$

$\Rightarrow \underline{xy}+x'y+\underline{xy'}\ \begin{bmatrix}\because a\cdot a=a\ ;\\ a\cdot a'=0\end{bmatrix}$

$\Rightarrow x(y+y')+x'y$

$\Rightarrow x+x'y\ [\because a+a'=1]$

Consider $a=x$

$b=x'$

$c=y$,

Using distributive law,

$\Rightarrow(x+x')(x+y)\ \left[\because a+bc=(a+b)(a+c)\right]\Rightarrow x+y\ [\because a+a'=1]$

$\Rightarrow$ L.H.S

Thus, L.H.S = R.H.S

Hence proved

1.10(b)

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

Consider R.H.S $x\equiv y\equiv xy$

The Equivalence of exclusive-OR is

$a\equiv b=ab+a'b'$

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

$\Rightarrow(xy+x'y')(xy)+(xy+x'y')'(xy)'$

Using DeMorgan's law, we get

$\Rightarrow(xy+x'y')(xy)+(xy)'(x'y')'(x'+y')$

$\left[\because(a+b)'=a'\cdot b'\ ;\ (ab)'=a'+b'\right]$

$\Rightarrow(xy+x'y')(xy)+\underline{(x'+y')}(x+y)\underline{(x'+y')}\ \left[\because(ab)'=a'+b'\right]$

$\Rightarrow(xy+x'y')(xy)+(x'+y')(x+y)\ [\because a\cdot a=a]$

$\Rightarrow(xyxy+xyx'y')+(x'x+x'y+y'x+y'y)$

$\Rightarrow(xy)+(x'y+y'x)\ \begin{bmatrix}\because a\cdot a=a\ ;\\ a\cdot a'=0\end{bmatrix}$

$\Rightarrow \underline{xy+x'y}+y'x$

$\Rightarrow y(x+x')+y'x$

$\Rightarrow y+y'x\ [\because a+a'=1]$

Consider $a=y$

$b=y'$

$c=x$,

Using distributive law, we get

$\Rightarrow(y+y')(y+x)\ \left[\because a+bc=(a+b)(a+c)\right]\Rightarrow 1.(y+x)\ [\because a+a'=1]$

$\Rightarrow x+y$

$\Rightarrow$ L.H.S

Thus, L.H.S = R.H.S

Hence proved

3.29

The expression for C_0 is

Output put expression of first half adder is

$C = AB$

$\Rightarrow C = XY \; [\because A = X \,;\, B = Y]$

Output put expression of second half adder is

$C = AB$

$\Rightarrow C = SC_i \; [\because A = S \,;\, B = C_i]$

$\Rightarrow C = (X \oplus Y)C_i \; [\because S = X \oplus Y]$

$\Rightarrow C = (X'Y + XY')C_i \; [\because a \oplus b = a' \cdot b + a \cdot b']$

$\therefore C = X'YC_i + XY'C_i$

C_0 is the sum of C's of both the half adder circuits which are connected by an OR gate.

Thus, the simplified sum-of-products expressions for the circuit output C_0 as

$C_o = C + C$

$\Rightarrow C_o = (XY) + (X'YC_i + XY'C_i)$

$\therefore \boxed{C_o = XY + X'YC_i + XY'C_i}$

$\text{SUM} = S \oplus B$

$\text{SUM} = (X \oplus Y) \oplus C_i \; [\because S = X \oplus Y]$

$\text{SUM} = \underline{(X'Y + XY')} \oplus C_i \; [\because a \oplus b = a' \cdot b + a \cdot b']$

$\text{SUM} = \underline{(X'Y + XY')}'C_i + (X'Y + XY')C_i' \; [\because a \oplus b = a' \cdot b + a \cdot b']$

Using DeMorgan's law,

$\text{SUM} = \left((X'Y)'(XY')'\right)C_i + X'YC_i' + XY'C_i' \; \left[\because (a+b)' = a' \cdot b'\right]$

$\text{SUM} = \left[(X + Y')(X' + Y)\right]C_i + X'YC_i' + XY'C_i' \; \left[\because (ab)' = a' + b'\right]$

$\text{SUM} = [XX' + XY + YX' + Y'Y]C_i + X'YC_i' + XY'C_i'$

$\text{SUM} = [XY + Y'X']C_i + X'YC_i' + XY'C_i' \; [\because a \cdot a' = 0]$

$\therefore \boxed{\text{SUM} = XYC_i + X'Y'C_i + X'YC_i' + XY'C_i'}$

X	Y	C_i	$(X \oplus Y)$	SUM $(X \oplus Y) \oplus C_i$	XY	$(X \oplus Y)C_i$	C_0 $XY + (X \oplus Y)C_i$
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	1	1	0	0	0
0	1	1	1	0	0	1	1
1	0	0	1	1	0	0	0
1	0	1	1	0	0	1	1
1	1	0	0	0	1	0	1
1	1	1	0	1	1	0	1

3.31(a)	3.31(b)
VALID: LHS $= (X' + Y')(X \oplus Z) + (X + Y)(X \oplus Z)$ $= (X' + Y')(X'Z' + XZ) + (X + Y)(X'Z + XZ')$ $= X'Z' + X'YZ' + XY'Z + X'YZ + XZ' + XYZ'$ $= X'Z' + (XY' + X'Y)Z + XZ'$ $= Z' + Z(X \oplus Y) = Z' + (X \oplus Y) =$ RHS	LHS $= (W' + X + Y')(W + X' + Y)(W + Y' + Z) = (W' + X + Y')(W + (X' + Y)(Y' + Z))$ $= (W' + X + Y')(W + (X'Y' + YZ)) = (W'(X'Y' + YZ) + W(X + Y')) = W'X'Y' + W'YZ + WX + WY'$ *consensus terms:* $X'Y'$ XYZ $= W'X'Y' + W'YZ + WX + WY' + XYZ + X'Y' = W'X'Y' + W'YZ + W'YZ + XYZ + WX + WY' + X'Y'$ $= W'X'Y' + W'YZ + XYZ + WX + X'Y' = W'YZ + XYZ + WX + X'Y'$
3.31(c)	
LHS $= ABC' + A'C'D' + A'BD' + ACD = AC(B + D) + A'D'(B + C') = (A + D'(B + C'))(A' + C(B + D))$ $= (A + D')(A + B + C')(A' + C)(A' + B + D) = (A + D')(A + B + C')(A' + C)(A' + B + D)(B + C' + D)$ *consensus:* $B + C' + D$ $= (A + D')(A + B + C')(A' + C)(B + C' + D) = (A + D')(A' + C)(B + C' + D) =$ RHS	