CSC 3501 Computer Organization and Design

Homework #2 Solution

Chapter 3. Review of Essential Terms and Concepts

6.

Minimization of Boolean expression provides simple analysis of circuit operations and also implementation takes lesser number of logic gate unites consists of transistors.

7.

The use of transistors for the construction of logic gates depends upon their utility as fast switches. When the base-emitter diode is turned on enough to be driven into saturation, the collector voltage with respect to ground may be less than a volt and can be used as a logic 0 in the TTL logic family. Also, if it is more than a threshold can be used as logic 1. Hence, transistors are basic building blocks for gates.

9.

Universal gates are the ones which can be used for implementing any gate like AND, OR and NOT, or any combination of these basic gates; NAND and NOR gates are universal gates. Hence, they are important as any kind of other gates are realized using them.

11.

When multiple full adders are used with the carry ins and carry outs chained together then this is called a ripple carry adder because the correct value of the carry bit ripples from one bit to the next. It is possible to create a logical circuit using several full adders to add multiple-bit numbers. Each full adder has an input, which is the output of the previous adder. This kind of adder is a ripple carry adder, since each carry bit "ripples" to the next full adder. However, the ripple carry adder is relatively slow, since each full adder must wait for the carry bit to be calculated from the previous full adder..

Chapter 3. Exercises

2.

a)

x	y	z	xyz	$x(yz)'$	$(xyz)'$	Sum
0	0	0	0	0	1	1
0	0	1	0	0	1	1
0	1	0	0	0	1	1
0	1	1	0	0	1	1
1	0	0	0	1	1	1
1	0	1	0	1	1	1
1	1	0	0	1	1	1
1	1	1	1	0	0	1

b)

x	y	z	$x+y$	$x + z$	$x' + z$	$(x + y)(x + z)(x' + z)$
0	0	0	0	0	1	**0**
0	0	1	0	1	1	**0**
0	1	0	1	0	1	**0**
0	1	1	1	1	1	**1**
1	0	0	1	1	0	**0**
1	0	1	1	1	1	**1**
1	1	0	1	1	0	**0**
1	1	1	1	1	1	**1**

4.

$$F(x,y,z) = xy + x'z + yz'$$
$$F'(x,y,x) = (xy + x'z + yz')'$$
$$= (xy)'(x'z)'(yz')'$$
$$= (x' + y')(x + z')(y' + z)$$

8.

a)

x	y	xy	xy'	$xy + xy'$
0	0	0	0	0
0	1	0	0	0
1	0	0	1	1
1	1	1	0	1

b)

$$
\begin{aligned}
xy + xy' &= x(y + y') \\
&= x(1) \\
&= x
\end{aligned}
$$

10.

a.
$$
\begin{aligned}
x'y + xyz' + xyz &= x'y + xy(z' + z) && \textit{Distributive} \\
&= x'y + xy(1) && \textit{Inverse} \\
&= x'y + xy && \textit{Identity} \\
&= (x' + x)y && \textit{Distributive} \\
&= (1)y && \textit{Inverse} \\
&= y && \textit{Identity}
\end{aligned}
$$

b.
$$
\begin{aligned}
(xy' + w'z)(wx' + yz') &= xy'wx' + xy'yz' + w'zwx' + w'zyz' && \textit{Distributive} \\
&= (xx')y'w + (y'y)xz' + (w'w)zx' + (zz')w'y && \textit{Associative} \\
&= (0)y'w + (0)xz' + (0)zx' + 0(w'y) && \textit{Inverse} \\
&= 0 + 0 + 0 + 0 && \textit{Null} \\
&= 0 && \textit{Idempotent}
\end{aligned}
$$

c.
$$
\begin{aligned}
(x + y)'(x'+y')' &= (x + y)'\,(x''y'') && \textit{DeMorgan} \\
&= (x'y')(x''y'') && \textit{DeMorgan} \\
&= (x'y')(xy) && \textit{Double Complement} \\
&= (x'x)(y'y) && \textit{Associative} \\
&= (0)(0) && \textit{Inverse} \\
&= 0 && \textit{Idempotent}
\end{aligned}
$$

12.

a. $(ab + c + df)ef$

a. $(ab + c + df)ef$	$=$ $abef + cef + dfef$	*Distributive*
	$=$ $abef + cef + deff$	*Commutative*
	$=$ $abef + cef + def$	*Idempotent*
b. $x + xy$	$=$ $x(1 + y)$	*Distributive*
	$=$ $x(1)$	*Null*
	$=$ x	*Idempotent*
c. $(xy' + x'z)(wx' + yz')$	$= xy'wx' + xy'yz' + x'zwx' + x'zyz'$	*Distributive*
	$= xx'y'w + y'yxz' + x'x'wz + zz'x'y$	*Commutative*
	$= (xx')y'w + (y'y)xz' + (x'x')wz + (zz')x'y$	*Associative*
	$= (0)y'w + (0)xz' + x'wz + (0)x'y$	*Inverse*
	$= 0 + 0 + x'wz + 0$	*Null*
	$= x'wz$	*Identity*

13.

b. $x'yz + xz$	$= x'yz + xz(1)$	*Identity*
	$= x'yz + xz(y + y')$	*Inverse*
	$= x'yz + xzy + xzy'$	*Distributive*
	$= x'yz + (xzy + xzy) + xzy'$	*Idempotent*
	$= (x'yz + xzy) + (xzy + xzy')$	*Associative*
	$= (x'yz + xyz) + (xyz + xy'z)$	*Commutative*
	$= (x' + x)yz + xz(y + y')$	*Distributive*
	$= (1)yz + xz(1)$	*Inverse*
	$= yz + xz$	*Identity*

c. $wx + w(xy + yz')$	$= wx + wxy + wyz'$	*Distributive*
	$= wx(1 + y) + wyz'$	*Distributive*
	$= wx(1) + wyz'$	*Null*
	$= wx + wyz'$	*Identity*

14.

Using identities:

$$
\begin{aligned}
yz + xyz' + x'y'z &= (x + x')yz + xyz' + x'y'z \\
&= xyz + x'yz + xyz' + x'y'z \\
&= (x'y'z + x'yz) + (xyz + xyz') \\
&= x'z(y' + y) + xy(z + z') \\
&= x'z + xy
\end{aligned}
$$

Using truth tables:

x	y	z	yz	xyz'	$x'y'z$	$yz + xyz' + x'y'z$	xy	$x'z$	$xy + x'z$
0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	1	1	0	1	1
0	1	0	0	0	0	0	0	0	0
0	1	1	1	0	0	1	0	1	1
1	0	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0
1	1	0	0	1	0	1	1	0	1
1	1	1	1	0	0	1	1	0	1

19.

$F(x,y,z) = x'y'z' + x'yz + xyz'$

20.

The truth table for $xz' + y'z + x'y$ is:

x	y	z	xz'	$y'z$	$x'y$	$xz' + y'z + x'y$
0	0	0	0	0	0	0
0	0	1	0	1	0	1
0	1	0	0	0	1	1
0	1	1	0	0	1	1
1	0	0	1	0	0	1
1	0	1	0	1	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	0

The complemented sum of two products forms is:

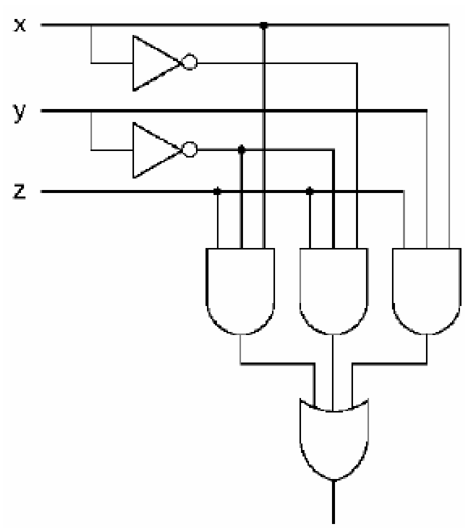
$$(x'y'z' + xyz)'$$

22.

a.

x	y	z	$xy'z$	$x'y'z$	xyz	F
0	0	0	0	0	0	0
0	0	1	0	1	0	1
0	1	0	0	0	0	0
0	1	1	0	0	0	0
1	0	0	0	0	0	0
1	0	1	1	0	0	1
1	1	0	0	0	0	0
1	1	1	0	0	1	1

b. Logic diagram for $xy'z + x'y'z + xyz$



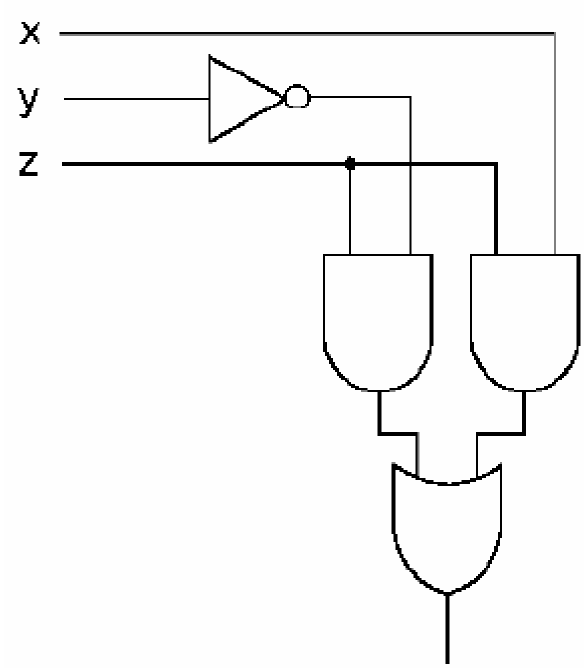
c. $xy'z + x'y'z + xyz$

$$\begin{aligned} xy'z + x'y'z + xyz &= (xy'z + xy'z) + x'y'z + xyz \\ &= (xy'z + x'y'z) + (xy'z + xyz) \\ &= (x + x')y'z + (y' + y)xz \\ &= y'z + xz \end{aligned}$$

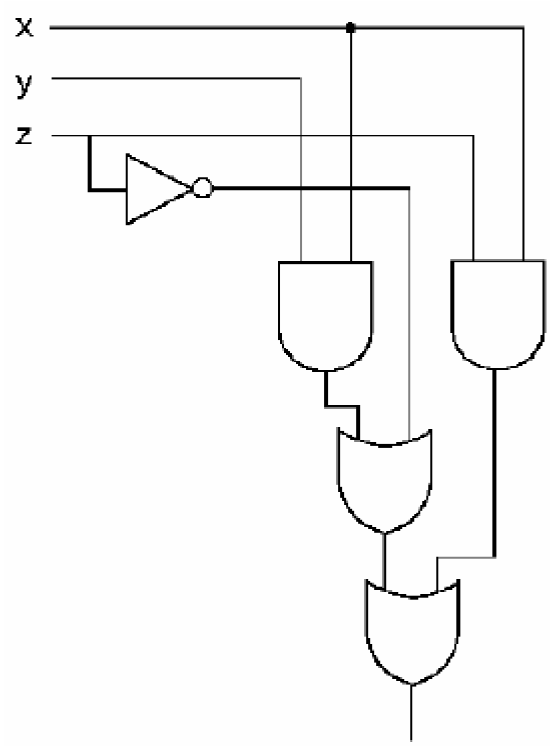
d.

x	y	z	$y'z$	xz	F
0	0	0	0	0	0
0	0	1	1	0	1
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	1	1	1
1	1	0	0	0	0
1	1	1	1	1	1

e. Logic diagram for *y'z* + *xz*:



26.



28.

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1