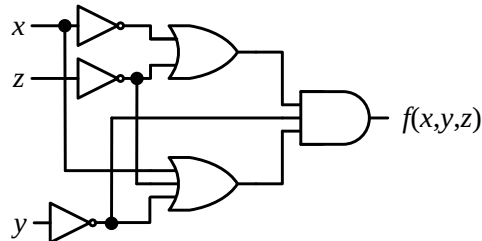


EE1001 - Tutorial 3

1. Using AND, OR, NOT gates to draw the logic circuit diagram of the Boolean function $f(x, y, z) = y'(x + z' + y')(x' + z')$. The diagram should correspond exactly to the equation. Assume that the complements of the inputs are not available.

Ans.



2. Proof $(A+B'C)' = A'(B+C')$ with truth table.

Ans.

A	B	C	$B'C$	$A+B'C$	$(A+B'C)'$	$B+C'$	A'	$A'(B+C')$
0	0	0	0	0	1	1	1	1
0	0	1	1	1	0	0	1	0
0	1	0	0	0	1	1	1	1
0	1	1	0	0	1	1	1	1
1	0	0	0	1	0	1	0	0
1	0	1	1	1	0	0	0	0
1	1	0	0	1	0	1	0	0
1	1	1	0	1	0	1	0	0

3. Simplify the Boolean expression $(A+B)(A+C)$.

Ans.

$$\begin{aligned}
 (A+B)(A+C) &= A(A+B) + C(A+B) \\
 &= A + AB + AC + BC \\
 &= A + BC
 \end{aligned}$$

4. For the following logic functions, find all the minterms and maxterms for each them and express them in canonical POS and SOP forms.

Ans.

$$\begin{aligned}
 \text{(a)} \quad f(x, y, z) &= xy'z' + yz + x'z' \\
 &= xy'z' + (x+x')yz + x'(y+y')z' \\
 &= xy'z' + xyz + x'y'z + x'yz' + x'y'z' \\
 &= m_0 + m_2 + m_3 + m_4 + m_7 \\
 &= \Sigma m(0, 2, 3, 4, 7) \\
 &= \Pi M(1, 5, 6) \\
 &= (x+y+z')(x'+y+z')(x'+y'+z)
 \end{aligned}$$

$$\begin{aligned}
(b) \quad f(x,y,z) &= xz' + x'y + xz + yz' \\
&= x + x'y + yz' \\
&= x + y + yz' \\
&= x(y+y') + y(x+x') \\
&= xy(z+z') + xy'(z+z') + x'y(z+z') \\
&= xyz + xyz' + xy'z + xy'z' + x'yz + x'yz' \\
&= m_2 + m_3 + m_4 + m_5 + m_6 + m_7 \\
&= \sum m(2,3,4,5,6,7) \\
&= \prod M(0,1) \\
&= (x+y+z)(x+y+z')
\end{aligned}$$

$$\begin{aligned}
(c) \quad F(A,B,C,D) &= A'(B+CD) + B'C + B(A+C) \\
&= A'B + A'CD + B'C + AB + BC \\
&= B + C + A'CD \\
&= B + C \\
&= \dots \\
&= \sum m(2,3,4,5,6,7,10,11,12,13,14,15) \\
&= \prod M(0,1, 8,9) \\
&= (A+B+C+D)(A+B+C+D')(A'+B+C+D)(A'+B+C+D')
\end{aligned}$$

5. For the following logic functions, list all the minterms and maxterms for each of them.

Ans.

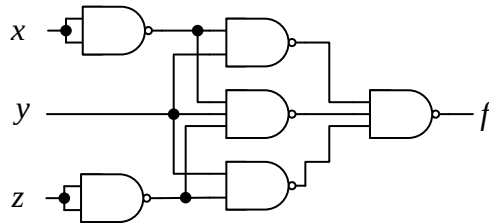
$$\begin{aligned}
(a) \quad f(x,y,z) &= \sum m(1,2,7) \\
&= x'y'z + x'yz' + xyz \\
&= \prod M(0,3,4,5,6) \\
&= (x+y+z)(x+y'+z')(x'+y+z)(x'+y+z')(x'+y'+z)
\end{aligned}$$

$$\begin{aligned}
(b) \quad f(w,x,y,z) &= \sum m(0,3,4,8,10,12,13) \\
&= w'x'y'z' + w'x'yz + w'xy'z' + wx'y'z' + wx'yz' + wxy'z' + wxy'z \\
&= \prod M(1,2,5,6,7,9,11,14,15) \\
&= (\dots)(\dots)(\dots)(\dots)(\dots)(\dots)(\dots)
\end{aligned}$$

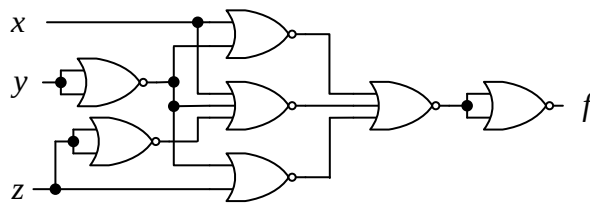
$$\begin{aligned}
(c) \quad f(a,b,c) &= \prod M(1,6) \\
&= (x+y+z')(x'+y'+z) \\
&= \sum m(0,2,3,4,5,7,8,9,10,11,12,13,14,15) \\
&= \dots
\end{aligned}$$

6. Using DeMorgan's theorem, convert the following Boolean expressions to equivalent expressions that can be implemented with (i) NAND gates only, and (ii) NOR gates only. Draw the circuits.

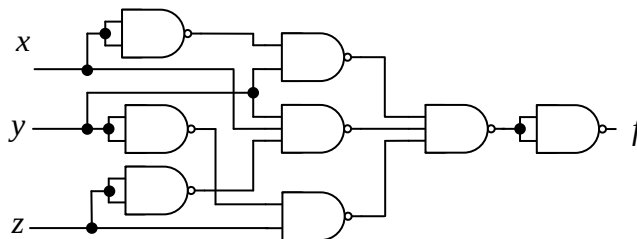
(a) $f = \bar{x}y + \bar{x}yz + y\bar{z}$
 $f = \overline{\overline{\bar{x}y + \bar{x}yz + y\bar{z}}}$
 $f = \overline{\overline{\bar{x}y} \overline{\bar{x}yz} \overline{y\bar{z}}}$ for NAND gate implementation.



$f = \overline{\overline{x + \bar{y} + x + \bar{y} + \bar{z} + \bar{y} + \bar{z}}}$ for NOR gate implementation.



(b) $f = (x + \bar{y})(\bar{x} + \bar{y} + z)(y + \bar{z})$
 $f = \overline{\overline{(x + \bar{y})} \overline{(\bar{x} + \bar{y} + z)} \overline{(y + \bar{z})}}$ for NAND gate implementation



$f = \overline{\overline{(x + \bar{y})} + \overline{(\bar{x} + \bar{y} + z)} + \overline{(y + \bar{z})}}$ for NOR gate implementation

