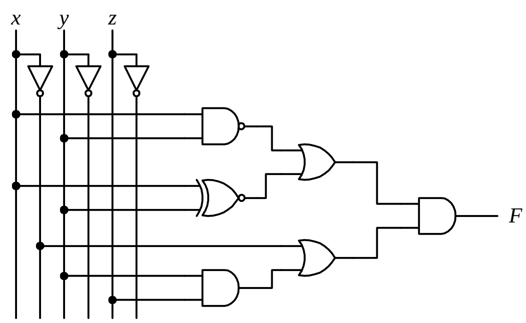
UNIVERSITY OF CALIFORNIA, RIVERSIDE
Department of Computer Science and Engineering
Department of Electrical Engineering
CS/EE120A –Logic Design
Midterm 1
April 22, 2003

______
24

Name:__Solution Key________________ **Student ID#:____________________**
Please print legibly

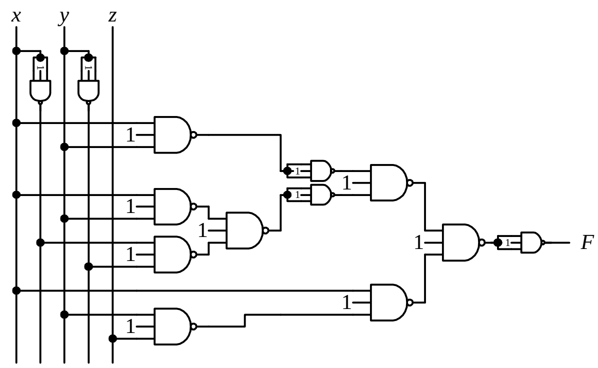
(Numbers in parenthesis denote total possible points for question.)

Questions 1 to 3 refer to the following circuit

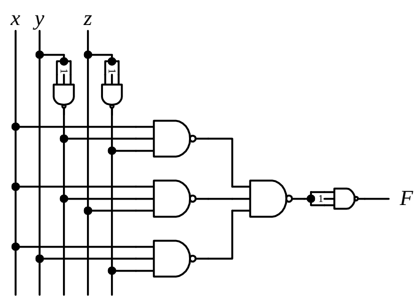


1. Convert the given circuit to a circuit that uses ONLY 3-input NAND. (4)

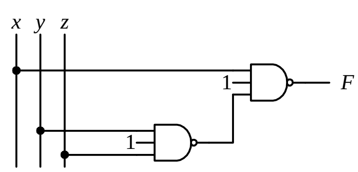
Answer



or



or



2. Derive the Boolean equation for the give circuit. (4)

Answer

$$
\begin{aligned}
F(x,y,z) &= [(xy)' + (x \odot y)]\,(x' + yz) \\
&= x' + yz \\
&= x' + xyz \\
&= (x(yz)'\,)' \\
&= (xy'z'\,)'\,(xy'z\,)'\,(xyz'\,)'
\end{aligned}
$$

3. Derive the truth table for the circuit. (4)

Answer

x	y	z	$(xy)'$	$(x \odot y)$	$[(xy)' + (x \odot y)]$	x'	yz	$x' + yz$	F	Maxterms
0	0	0	1	1	1	1	0	1	1	M_0
0	0	1	1	1	1	1	0	1	1	M_1
0	1	0	1	0	1	1	0	1	1	M_2
0	1	1	1	0	1	1	1	1	1	M_3
1	0	0	1	0	1	0	0	0	0	M_4
1	0	1	1	0	1	0	0	0	0	M_5
1	1	0	0	1	1	0	0	0	0	M_6
1	1	1	0	1	1	0	1	1	1	M_7

4. Use the truth table from question 3 to derive the Boolean equation in the product-of-maxterms format. Write the equation using the shorthand notation symbol. (4)

Answer

$$F(x,y,z) = \Pi(4, 5, 6)$$

$$= (x' + y + z)\,(x' + y + z')\,(x' + y' + z)$$

5. Use Boolean algebra to show that the two equations that you derived in questions 2 and 4 above are equivalent. (4)

Answer

$$
\begin{aligned}
F &= [(xy)' + (x \odot y)]\,(x' + yz) \\
&= (x' + y' + x'y' + xy)\,(x' + yz) \\
&= (x' + y' + x' + x)\,(x' + y' + x' + y)\,(x' + y' + y' + x)\,(x' + y' + y' + y)\,(x' + yz) \\
&= 1 \bullet 1 \bullet 1 \bullet 1 \bullet (x' + yz) \\
&= (x' + y)\,(x' + z) \\
&= (x' + y + z')\,(x' + y + z)\,(x' + y' + z)\,\cancel{(x' + y + z)} \\
&= M_4 \bullet M_5 \bullet M_6 \\
&= \Pi(4,5,6)
\end{aligned}
$$

Take off 2 points if go directly from Σ to Π.

Take off 2 points if obtain Π directly from the truth table.

The answer MUST be derived from the Boolean algebra Theorems

6. Use Boolean algebra to reduce the following function as much as possible in terms of the number of gates needed to implement the function (4).

$$F = (x \odot y)\,(x + y')'$$

Answer

$$
\begin{aligned}
F &= (x \odot y)\,(x + y')' \\
&= (xy + x'y')\,(x'y) \\
&= xyx'y + x'y'x'y \\
&= 0 + 0 \\
&= 0
\end{aligned}
$$