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CSC 362 Homework #2

Due Date: Wednesday, September 11

**Word process all answers** (figures (#6) and tables (#1, #4b) may be hand drawn), **show all work or you may not receive any credit**. For simplifications, you do not need to provide the names of identities used. The 7 questions are each worth 14 points, problems with multiple parts (e.g., 1a, 1b) are equally weighted (e.g., 1a is worth 7 points, 2b is worth 7 points, etc).

1. Construct a truth table for each of the following Boolean expressions.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **x** | **y** | **z** | **x’** | **y’** | **z’** | **x\*y** | **x\*y + z’** | **x’+y’** | **F= (x\*y + z’) (x’+ y’)** |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | **0** |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | **1** |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | **0** |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | **1** |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | **0** |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | **1** |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | **1** |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | **1** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **a** | **b** | **c** | **d** | **a’** | **b’** | **c’** | **d’** | **a\*b\*c’** | **a’\*c\*d’** | **c\*d** | **a\* b’ \* c’ \* d** | **G** |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | **0** |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **0** |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | **1** |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | **1** |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | **0** |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **0** |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | **1** |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **1** |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | **0** |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | **1** |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | **0** |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | **1** |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | **1** |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | **1** |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | **0** |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **1** |

1. Simplify the following Boolean statements. You do not need to specify which identities you are using. Note that

= A’ \*C\* D + A’ \* ( A’ + B’ ) + A\* C\* D

= A’ \*C\*D + A’ \*A’ + A’\* B’ + A\* C\* D

= A’ \*C\*D + A’ + A’ \*B’ + A\* C\* D

= C\*D \* ( A’ + A ) + A’\* ( 1 + B’)

= C\*D \* (1) + A’ \*(1)

= C\*D + A’

= (x\*y)’ \* z’ + x’ \* (y\*z)’ + ( x’’ \* y’ )

= (x’ + y’)\*z’ + x’ \* (y’ + z’ ) + ( x \* y’ )

= x’\*z’ + y’\*z’ + x’\*y’ + x’\*z’ + ( x \* y’ )

= x’\*z’ + y’\*z’ + x’\*y’ + x \* y’

= x’\*z’ + y’(z’ + x’ + x)

= x’\*z’ + y’(z’ + 1)

= x’\*z’ + y’( 1)

= x’ \* z’ + y’

1. F = , G = show (and reduce) each of , , , and . When done, you should have to prove that DeMorgan’s Law holds for F and G. Note: you will need to apply DeMorgan’s Law in doing your reductions. NOTE: for , you may reach a point where you have to take one of your terms and add \* 1 to continue to simplify it to the result of .

**F’** = (x + z’ )’

= x’ \* z

**G’** = ((x’ \* y) + z)’

= (x’ \* y)’ \*(z)’

= (x + y’) \*z’

= x\*z’ + y’\*z’

**F \* G** = ( x + z’ ) \* ( x’ \* y +z)

= x \* ( x’ \* y +z) + z’ \* ( x’ \* y +z)

= (x \* x’ \* y + z \*x) + (z’ \* x’ \* y + z \* z’ )

= ( 0 + x \* z ) + ( x’ \* y \* z’ + 0)

= ( x \* z ) + ( x’ \* y \* z’)

**( F \* G )’** = ( (x + z’) \* (x’ \* y + z ))’

= ( x + z’)’ + ((x’\*y) + z )’

= ( x’ \* z) + (x’\*y)’ \* z’

= ( x’ \* z) + ((x + y’) \* z’ )

= x’ \* z + x\*z’ + y’\*z’

**F’ + G’** = x’\*z + x\*z’ + y’\*z’

So, I have proved that DeMorgan’s Law holds for F and G.

1. Prove the following two expressions are equal by showing that
   1. the left-hand side and right-hand side simplify to the same expression
   2. both sides have the same truth table results

Note that the right-hand side does not have a w, for the truth table this means that the results are the same for w = 0 and w = 1, that is, the RHS expression should still have 16 rows where it doesn’t matter what w is.

**LHS:**

**=** w\*y + w\*x\*z’ + ( x’\* y’’ )+ (w’ \* y’’) + (x’’ \* z’)

**=** w\*y + w\*x\*z’ + ( x’\* y )+ (w’ \* y) + (x \* z’)

= y \* ( w + w’ + x’) + w \* x\* z’ + x\*z’

= y \* ( 1 + x’ ) + x\*z’ \* ( w + 1)

= y \* 1 + x\*z’ \* 1

= y + x\*z’

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **w** | **x** | **y** | **z** | **w’** | **x’** | **y’** | **z’** | **w\*y** | **w\*x\*(z’)** | **(x+(y’))’** | **(w+(y’))’** | **((x’)+z)’** | **LHS** |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **0** |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | **1** |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | **1** |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | **1** |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | **1** |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | **1** |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | **1** |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | **1** |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | **1** |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | **1** |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | **1** |

**RHS:**

= y’’ + ((x’) + z)’

= y + (x’’ + z’)

= y + (x \* z’)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **w** | **x** | **y** | **z** | **x’** | **y’** | **(x’+z)** | **y’\*((x’)+z)** | **RHS = (y’\*((x’)+z))’** |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | **0** |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | **0** |
| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | **1** |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | **1** |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | **1** |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | **0** |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **1** |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | **1** |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | **0** |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | **0** |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | **1** |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | **1** |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | **1** |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | **0** |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | **1** |
| 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | **1** |

1. Use sum of products to obtain the Boolean expression that matches the truth table below and then simplify the expression as much as possible.

|  |  |  |  |
| --- | --- | --- | --- |
| X | Y | Z | Function |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 |

Function =

= x’\*y’\*z’ + x’\*y’\*z + x’\*y\*z + x\*y’\*z’ + x\*y’\*z + x\*y\*z

= x’\*y’\* (z’ + z) + y\*z \* (x’ +x) + x\*y’ \* (z’ + z)

= x’\*y’\* (1) + y\*z \* (1) + xy’ \* (1)

= x’\*y’ + y\*z + x\*y’

= y’ \* (x’ + x ) + y\*z

= y’ \* (1) + y\*z

= y’ + y\*z

1. Draw the circuits for the expressions (unsimplified) from question number 1.

A drawing of a diagram

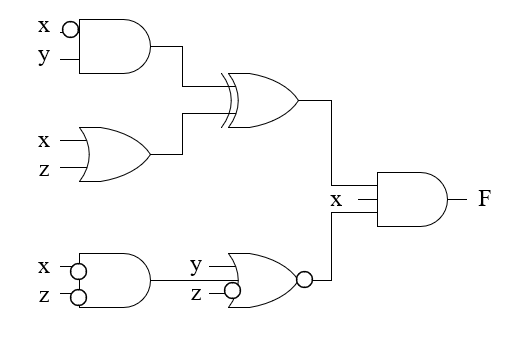
Description automatically generated

A drawing of a diagram

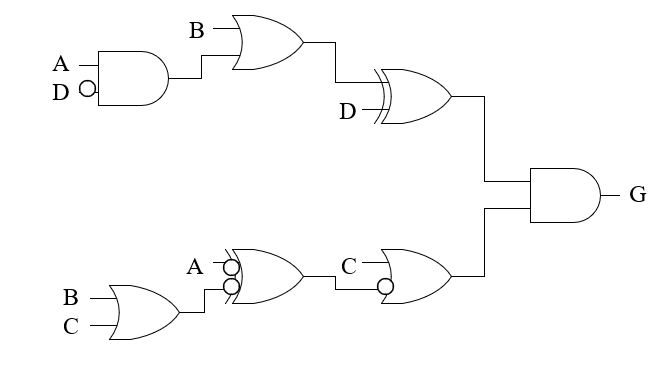
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1. Provide the Boolean expression for each of the following circuits. Do not simply your expressions.



**F = ((x’\*y) XOR (x+z)) \* x \* (( x’ \* z’ + ( y + z’ ))’**

b.

**G = (( B + A\* D’) XOR D) \* (C + ( A’ XOR ( B + C )’)’ )**