EECE 144
Fall 2011

Lab Report #2
Section 4
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Submitted by:

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1 Description/Objectives

This lab illustrates how create and verify equivalent logic functions manually and with Logisim [1].

2 Procedure

Given two different logic functions (Equations 1, 2) the task is to verify that they are logically equivalent.

$$ab + c' + abc \tag{1}$$
$$ab + c' \tag{2}$$

For each logic function the following steps are performed:

1. Define the function with logic gates in Logisim.
2. Using the Logisim simulation generate all combinations of inputs and record the corresponding output as a truth table.
3. Manually calculate the outputs for every combination of inputs as a second truth table.
4. Verify that the simulated outputs are the same as the manually calculated outputs.

As a final step, since we know the functions are equivalent, we algebraically manipulate one of the given functions in to the form of the second function.

2.1 Verify $ab + c' + abc$

Figure 1 shows the circuit as it was defined in Logisim. Figure 2 shows the output from Logisim and the manual calculations.

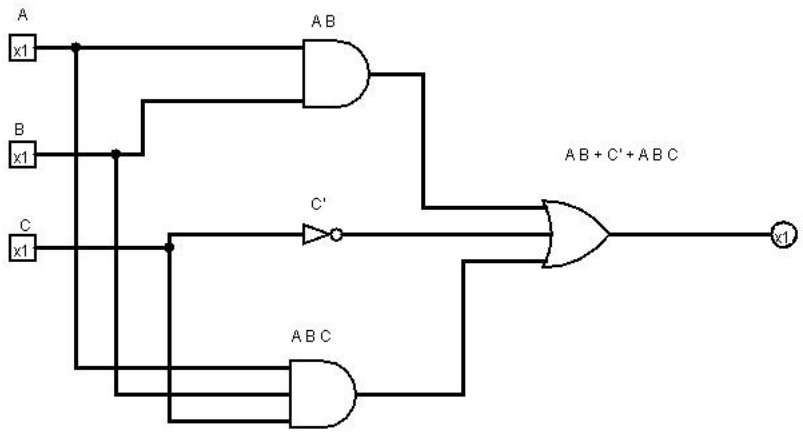

Figure 1: Logic circuit $ab + c' + abc$ defined in Logisim.

$ab + c' + abc$				
a	b	c	Logisim out	manual out
0	0	0	1	1
0	0	1	0	0
0	1	0	1	1
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	1	1
1	1	1	1	1

Figure 2: Truth table of outputs for the function $ab + c' + abc$ simulated in Logisim and calculated manually.

2.2 Verify $ab + c'$

Figure 3 shows the circuit as it was defined in Logisim. Figure 4 shows the output from Logisim and the manual calculations.

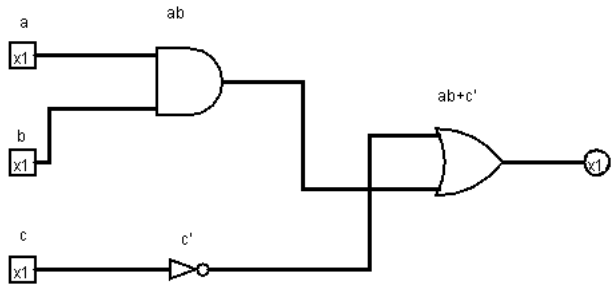

Figure 3: Logic circuit $ab + c'$ defined in Logisim.

$ab + c'$				
a	b	c	Logisim out	manual out
0	0	0	1	1
0	0	1	0	0
0	1	0	1	1
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	1	1
1	1	1	1	1

Figure 4: Truth table of outputs for the function $ab + c'$ simulated in Logisim and calculated manually.

2.3 Reduction of $ab + c' + abc$ in to $ab + c'$

Additionally, to verify that the logic functions are equivalent, the first function ($ab + c' + abc$) is algebraically manipulated/reduced using the Laws of Boolean Algebra [2, Pg. 55] in to the form of the second ($ab + c'$) as shown in Figure 5.

$$
\begin{aligned}
ab + c' + abc & \\
ab + abc + c' & \quad \text{(Commutative Law)} \\
a(b + bc) + c' & \quad \text{(Distributive Law)} \\
a(b(1 + c)) + c' & \quad \text{(Distributive Law)} \\
ab + c' & \quad \text{(0/1 Law, } X + 1 = 1\text{))}
\end{aligned}
$$

Figure 5: Reduction of $ab + c' + abc$ in to $ab + c'$

3 Observations

For both functions it was found that the circuit created in Logisim agreed with the expected behaviour as was calculated manually. And it was found through reduction using Boolean Algebra that the both functions were logically equivalent.

4 Conclusion

This lab was a success in showing that there are various ways to verify logic functions that appear to be different to see if they are logically equivalent. The functions can be manually calculated or simulated in Logisim. And the output for every possible combination can be organized in a truth table for comparison. The functions can also be algebraically manipulated using Boolean Algebra to show if they are equivalent.

5 References

[1] Logisim, "Logisim, a graphical tool for designing and simulating logic circuits." `http://ozark.hendrix.edu/~burch/logisim/`, 2011.

[2] C. R. Jr., Fundamentals of Logic Design. Cengage Learning, 2009.