CSE140 HW1, Due Mon. 4/17/2017 by 11:59PM

1 Introduction

The purpose of this assignment is three-fold. First, it aims to help you practice the application of Boolean Algebra theorems to transform and reduce Boolean expressions. The second goal is to help you learn how to go from the world of Boolean expressions to the world of digital circuits. The final goal is to help you translate a problem described in words to a Boolean algebraic expression. We hope you can think of why each of these exercises is useful when designing digital circuits.

2 Application of Boolean Algebra Theorems

2.1 Prove the following equations using Boolean algebra:

A. ad + bc'd'+abc'= ad + bc'd'
B. (a+d)(b+c'+d')(a+b+c')=(a+d)(b+c'+d')
  Are the above equations related to the consensus theorem?

2.2 Prove the above two equations using Shannon's expansion.

3 From Problem to Boolean Expression

A majority voting machine inputs four binary bits (x_3, x_2, x_1, x_0), and outputs $y = 1$ when the more than half of the input bits are 1. Otherwise, the output is $y = 0$.
i. Write the truth table.
ii. Write the functions in sum-of-products canonical form.
iii. Write the functions in product-of-sums canonical form.

4 Boolean Algebra and Implementation

i. Simplify each of the following two Boolean equations.
ii. Sketch a reasonably simple combinational circuit implementing the simplified equation.
iii. Compare the numbers of literals and operators versus the numbers of gates, nets, and pins in the schematic diagrams
A. $a'bc' + a'b'd + a'b'cd' + bc'd + acd + abcd' + ac'd$
B. $(a + b + c + d')(a + b + c + d)(a + b + c')(a' + b + c + d)(a' + c + d')(a' + b + c' + d)$

5   Bluespec Adder
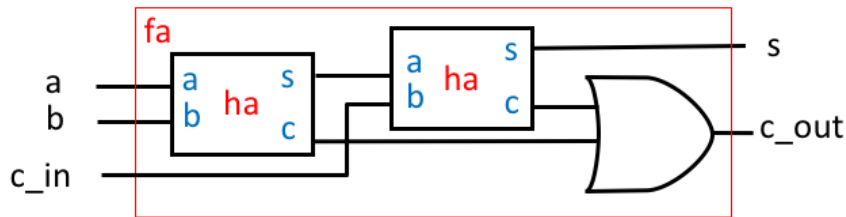
Complete the following implementation of a full adder using '&', '|', '!' and bit selection []. Remember that for `Bit(n) x`, `x[0]` represents the Least Significant Bit (LSB) of `x`. Please refer to *BSV by Example* for any syntax, semantics of Bluespec.

```
function Bit#(2) fa(Bit#(1) a, Bit#(1) b, Bit#(1) c_in);
    Bit#(2) ab = ha(a, b);

    Bit#(2) abc = ha( _____, _____);

    Bit#(1) c_out =  _____;

    return {c_out, _____};
endfunction
```

6   Assignment Turn-in

Once you're finished with the assignment, turn it in as a pdf on *TritonED*. To submit your assignment on *TritonED*, click on *Content* on the left menu. Choose the assignment you want to submit from the list and follow the turnitin instructions.