**Lab 1: Conditional Subtractor**

**Part 1 Deliverables:**

1. See Figure 1 below:

Diagram

Description automatically generated

Figure 1: Circuit diagram of subMax function

2. See attached files *submax.vhd* and *comp.vhd*

3. See attached file *submax\_tb.vhd.* See Figure 2 below for functional simulation results:

A screenshot of a computer

Description automatically generated

Figure 2: Functional Simulation of submax.vhd using submax\_tb.vhd

**Part 2 Deliverables:**

1. See attached file *submax2.vhd.*

2. See attached file submax2\_tb.vhd. See below for functional simulation results:

Graphical user interface

Description automatically generated

Figure 3: Functional Simulation of submax2.vhd using submax2\_tb.vhd

**Part 3 Deliverables:**

1. See attached file *submax\_top.vhd*

2. n/a

3. Answer the following questions. Use as inputs *x* = 15, *y* = 9

1. What answer do you get?

When *x* = 15 (SW[7:4] all toggled ‘on,’ corresponding to 0b1111) and *y* = 9 (SW[3] and SW[0] toggled on, corresponding to 0b1001), the answer was 6 (LD[6] and LD[5] illuminated, corresponding to 0b0110).

1. Change the greater of the two inputs with the answer from question a. What is the output of the circuit? (So *x* = (answer from part a), and *y = 9*.

When *x* = 6 (SW[6] and SW[5] toggled ‘on,’ corresponding to 0b0110) and *y* = 9 (SW[3] and SW[0] toggled on, corresponding to 0b1001), the answer was 3 (LD[5] and LD[4] illuminated, corresponding to 0b0011).

1. Continue replacing the greater of the two inputs with the output until the two inputs are the same and therefore the output is zero. What is the value of the two inputs when they are the same?

The value of the two inputs when they are the same is 3 (0b0011).

1. Is there a relationship between this output and the original inputs of 15 and 9? Hint: Think of dividing the original *x* and *y* by the final answer. What is the relationship?

The output is of this series of inputs is equal to the greatest common denominator of the two input values. That is, if the two inputs 15 and 9 were divided by the output 3, the quotient of the two operations would be 5 and 3, respectively. Neither value can be reduced by further similar operations that would result in an integer value other than 1, proving that 3 is the greatest common denominator of the two input values.

You can use this circuit to iteratively compute the **greatest common denominator** of two numbers.