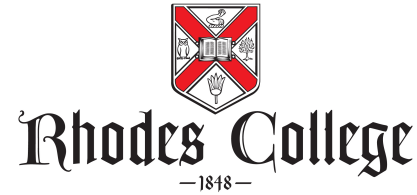


# COMP 231

## Introduction to Computer Organization

### Lab 2



This lab will consist of a Quartus project folder, submitted as a single ZIP file, via Canvas (<http://canvas.rhodes.edu/>). **You must submit a .zip file in the following format, otherwise you will lose points.** When you submit your project, rename the project folder to `<name_lab2>`, where the name is your Rhodes email ID. Then, ZIP the folder up and upload it to Canvas. Do not use any other compression/archiving format other than ZIP.

## Hardware Adder

For this lab, you will be creating a circuit which takes a pair of two-bit values from the switches on the DE2-115, adds them together, creating a 3-bit value which will be displayed on the LED lights. Create a new Quartus project, `adder`, in your `name_lab2` folder.

The inputs are signified as  $a_1a_0$  and  $b_1b_0$ . The output is signified as  $c_2c_1c_0$ . You are computing the following expression assuming unsigned binary integer representation:

$$\begin{array}{r} + \quad \quad \quad a_1 \quad a_0 \\ \quad \quad \quad b_1 \quad b_0 \\ \hline c_2 \quad c_1 \quad c_0 \end{array}$$

## Analysis

You will need to compute a truth table that will help you determine the values for  $c_2$ ,  $c_1$ , and  $c_0$ . From this truth table, derive minimal sum of products equations for each of the output functions. You will need to turn in this analysis on the due date in class on paper or submit a picture of it through Canvas. **You should not use a design based on the ripple-carry adders discussed in class.** Your solution should perform the addition directly in terms of all of the input signals, without introducing the propagation delay inherent in a ripple-carry system.

## Circuit Design

Using Quartus II, implement the combinational circuits that you derived. For the addition circuit, you may only use **and gates, or gates, or inverters/not gates**. You may not use any built-in addition circuits from the Quartus library. Compile and deploy your design to the DE2 board. Verify that the design and implementation is correct and works. It will be easier to use the DE2-115 pin assignments file that can be found on Canvas, than the physical pin names as used in the tutorial. You can use the logical names `LEDR[0]`, `LEDR[1]`, and `SW[0]`, etc. as the pin names associated with the switches and LED lights. **Your submission should use multiple blocks (one for each output).** There is a tutorial document on Canvas about using blocks within the Quartus schematic editor.

## Submission

When you have completed this entire exercise and have a functioning program, submit your lab 2 project folder as specified above to Canvas.