CS 061 – Computer Organization Homework 3

1. **(5 points)**

Design a digital combinational logic circuit with four inputs: a, b, c & d, where (a, b) represents a 2-bit unsigned binary number X; and (c, d) represents a 2-bit unsigned binary number Y (i.e. both X and Y are in the range #0 to #3).
The circuit has a single output z, which is 1 whenever X > Y, and 0 otherwise (this circuit is part of a "2-bit comparator").
For instance, if a = 1, b = 0, c = 0, d = 1; then z = 1, since b10 > b01

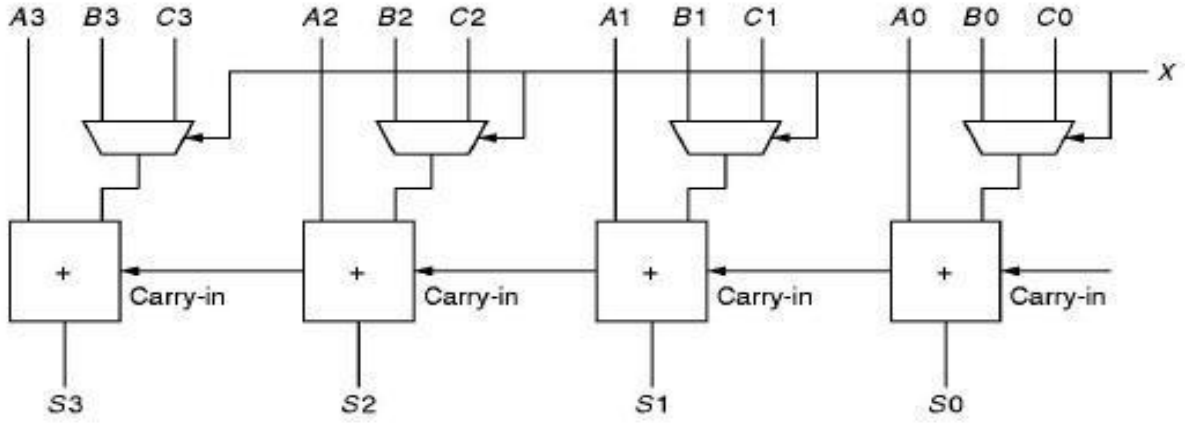
Start by drawing up the truth table, then derive the corresponding algebraic expression, and simplify it (your final expression will have three terms).

Now, use logisim to draw the actual logic circuit implementing the algebraic equation.

Finally, use logisim to actually test your circuit:
First make sure Simulation is enabled, then "poke" values of 1 and 0 to the inputs: observe the output in each case, and make sure its behavior corresponds to your truth table.
Show ***all*** your working, including the truth table and the steps by which you simplify the boolean expression.

When you're done, save your circuit as an image *(I suggest gif or png, rather than jpeg, with "Printer View" selected)*, and embed the image in your homework document.

2. 3.24 **(2 points)**



a) Fig. 3.29 shows a logic circuit that appears in many processors.
Here, it has three 4-bit inputs, A, B, and C; and a single 4-bit output, S.
Each of the boxes is a full-adder circuit.
What does the value on the wire X do? That is, what is the difference in the output of this circuit if X = 0 vs if X = 1?

b) Construct a logic diagram that implements an **adder/subtracter**.
That is, the logic circuit will compute **A + B** or **A – B** depending on the value of **X**.
Hint: Use the logic diagram of Fig. 3.29 as a starting point: you will just need to make a few simple modifications to it..

3. 3.30 **(2 points)**

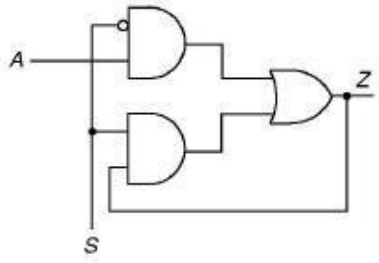
A comparator circuit has two 1-bit inputs A and B and three 1-bit outputs:
G (greater), E (Equal), and L (Less than).

a) Draw tthe truth table for a 1-bit comparator (inputs A & B; outputs G, E, L)

b) Implement G, E, and L using AND, OR and NOT gates.

c) Using the 1-bit comparator as a basic building block, construct a four-bit equality checker, such that output EQUAL is 1 if A[3:0] = B[3:0], and 0 otherwise.

4. 3.27 **(1 point)**



a) Describe the output of this logic circuit when the select line S is a logical 0. That is, what is the output Z for each value of A?

b) If the select line S is switched from a logical 0 to 1, what will the output be?

c) Is this logic circuit a storage element?