CSC205 section 1 Spring 2015
Homework 3

How to Submit:
Please submit your solutions (parts A and B separately) through Blackboard. Remember to put your name and homework number on all the documents that you submit as attachments.

Total possible points in this homework: 3 for Part B
(You receive 1 bonus point towards Part A if you get all Part A questions correct.)

Part A

1. You are given the following function:
   *F = (~(x*y) + x*y)*~y*
   i. Simplify the function using Boolean algebra and its identities.
   ii. Construct a truth table for the original function to verify your answer for (i);
   iii. Construct a simple digital circuit for the function.

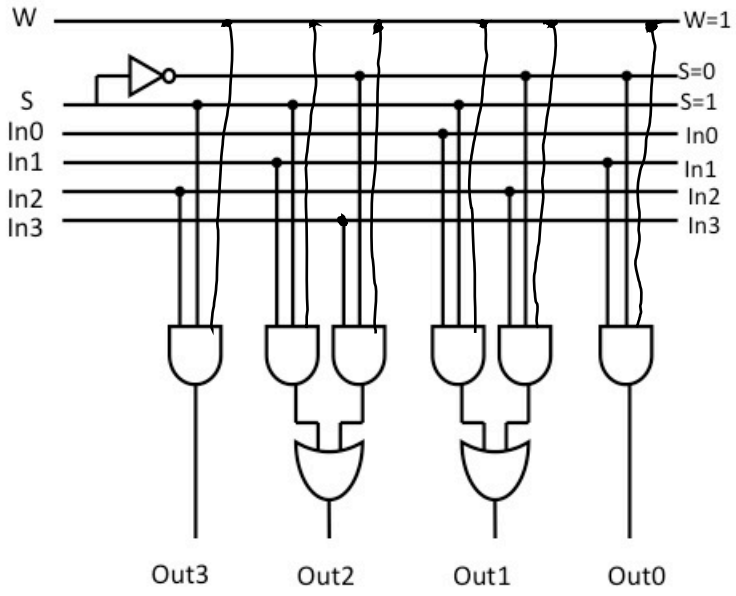
2. You are given the following:
   - one 8-bit input, of the form A=(A_7 A_6 A_5 A_4 A_3 A_2 A_1 A_0), and
   - a bunch (as many as you need) of logic gates (AND, OR, NOT, XOR, NOR, NAND etc). You may use multi-input AND gates and OR gates if needed.

   Assuming A is an 8-bit signed integer in 2s-complement, show how to construct a combinational circuit that tests A to produce the output =(S_2 S_1 S_0), such that:
   S_0 is 1 if and only if A is negative,
   S_1 is 1 if and only if A is zero, and
   S_2 is 1 if and only if A is positive.

3. Complete the following table, which describes the behavior of a 3-to-8 decoder.

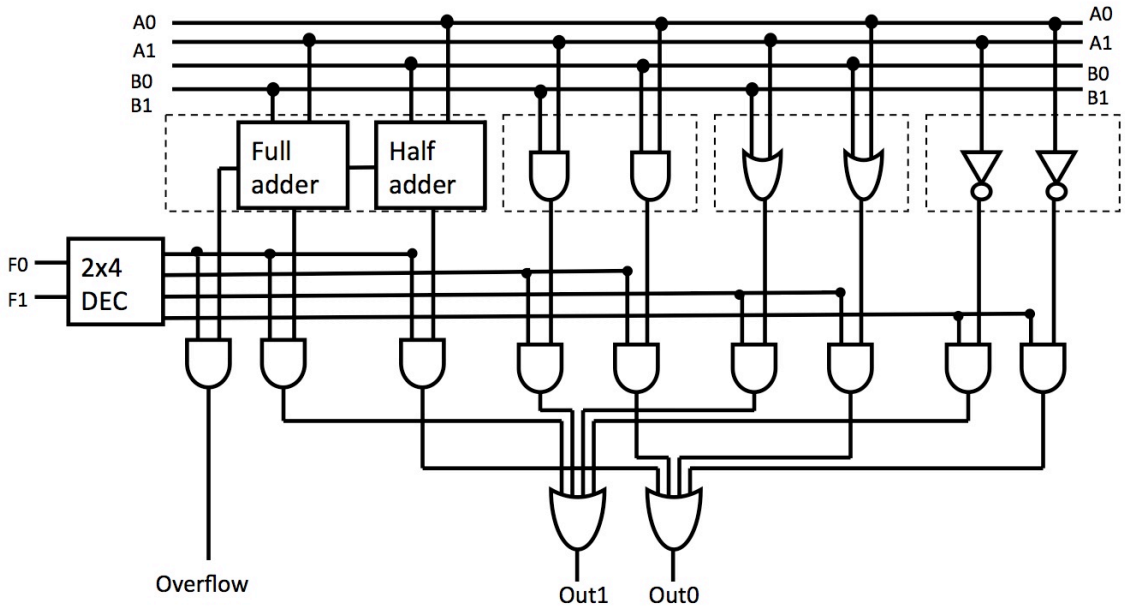
			xyz	xy'z'	x'y'z	xy'z'	x'yz	x'yz'	x'y'z	x'y'z'
In2	In1	In0	Out7	Out6	Out5	Out4	Out3	Out2	Out1	Out0
0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	1	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	1	0	0	0
1	0	0	0	0	0	1	0	0	0	0
1	0	1	0	0	1	0	0	0	0	0
1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0

4. The bit-shifter discussed in class always produces an output that is either a left-shift or a right-shift of the input. Add an input W as the control signal, so that the bit-shifter produces its expected outputs when W=1, but it produces all zeroes when W=0. Show how to connect W to the rest of the circuit in the diagram below. You may use multi-input AND gates and OR gates if needed.



Part B

5. [Total 3 pts] This question relates Boolean algebra to digital circuitry, and studies its application on circuit design.
   a. [1 pt] Consider a 3-to-8 decoder with inputs (A_2, A_1, A_0) and outputs (B_7,…,B_0). Describe each output B_i in terms of a Boolean expression of the inputs.
   b. [1 pt] Consider a 4-to-1 multiplexer with inputs (A_3, A_2, A_1, A_0), selects (B_1, B_0) and output C. Describe the output C in terms of a Boolean expression of all the inputs.
   c. [1 pt] Consider the following simple ALU discussed in class. Reconstruct it using multiplexers in place of the decoder to yield equivalent results.



6. [Total 1 bonus pt] Verilog is one of the most commonly used circuit design languages today. Its syntax is very similar to C/C++. Consult the verilog tutorials provided by the following links.

   http://electrosofts.com/verilog/mux.html

   (optional) http://electrosofts.com/verilog/introduction.html

   Then write:

   a. [0.5 pt] A verilog module to define a simple 8-to-1 multiplexer with inputs `d` and `select`, and output `q`;

   b. [0.5 pt] A test bench to your multiplexer for the following input values:

`d`	`select`
00000001	For each value of `d` given (on the left), try all possible combinations of value of `select`
00000010	
00000100	
00001000	
00010000	
00100000	
01000000	
10000000	