Cpr E 281 HW06

ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Arithmetic Circuits and Combinational-Circuit Building Blocks
Assigned Date: Seventh Week
Due Date: Monday, Oct. 10, 2016

P1. (20 points)
Consider the addition of the two ***n*-bit 2's complement** numbers:

$$X = x_{n-1}x_{n-2}\ldots x_1x_0$$
$$Y = y_{n-1}y_{n-2}\ldots y_1y_0$$

Suppose the sum is $S = s_{n-1}s_{n-2}\ldots s_1s_0$ and the carry is $C_n = c_nc_{n-1}c_{n-2}\ldots c_1c_0$.

a) (5 points) If X is positive, Y is negative, and c_{n-1}=0, what should be the values of c_n and s_{n-1} ? Will overflow occur?
b) (5 points) If X is negative, Y is negative, and c_{n-1}=0, what should be the values of c_n and s_{n-1} ? Will overflow occur?
c) (5 points) Following the idea in part (a) and (b), please construct a truth table for the values of c_n and s_{n-1} for all combinations of the sign of X, the sign of Y, and the value of c_{n-1}. For each combination, please also state if overflow occurs or not.
d) (5 points) Based on the truth table in part (c), prove that Overflow = $c_n \oplus c_{n-1}$.

P2. (10 points)
In class we learned that a carry-lookahead adder is faster than a ripple-carry adder. Could you explain why sometimes a designer might still choose a ripple-carry adder instead of a carry-lookahead adder?

P3. (10 points)
Perform the following conversions.

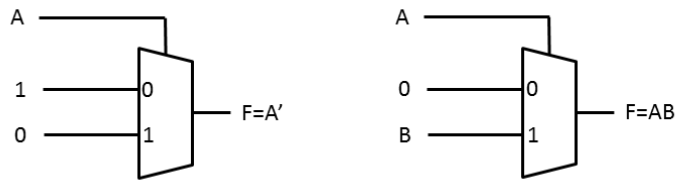
a) (5 points) Decimal number 5.375 to fixed-point number.
b) (5 points) Fixed-point number 1101.0111 to decimal number.

P4. (10 points)
Convert the decimal number 15.625 to IEEE 754 single-precision floating number format.

P5. (10 points)
Convert the following IEEE 754 single-precision floating number to decimal number.

1 01111110 0110000 00000000 00000000

P6. (20 points)
The following two examples illustrate how to implement NOT and AND functions with 2-to-1 multiplexers.



Use only 2-to-1 multiplexer to implement each of the following functions:

a) (5 points) $F(A,B) = A + B$ (OR)
b) (5 points) $F(A,B) = A \oplus B$ (XOR)
c) (5 points) $F(A,B) = \overline{A \bullet B}$ (NAND)
d) (5 points) $F(A,B) = \overline{A + B}$ (NOR)

Assume the inverse of each input variable is available. (i.e., you can directly use the inverse of each input variable *A* or *B* in your answer.)

P7. (10 points)
Use only 2-to-1 multiplexers to implement the circuit for the following function:

$$F(A,B,C) = \prod M(1,2,4,5)$$

Assume the inverse of each input variable is available. (i.e., you can directly use the inverse of each input variable *A*, *B*, or *C*, in your answer.)

P8. (10 points)
Repeat P7, but this time using only one 4-to-1 multiplexer.