Cpr E 281 HW06
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Representation and Arithmetic
Assigned: Week 7
Due Date: Oct. 5, 2020

P1 (8 points): For the grid below, shade the boxes for each number in the column that can be represented with only 3-bits under the format for that particular row.

	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Unsigned																	
Sign & Magnitude																	
1's Complement																	
2's Complement																	

P2 (12 points): Perform the following operations on the numbers and indicate if overflow occurs for each operation. All numbers are 6 bits wide (stored in 2's complement). Show your work and all carry bits.

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  011001        110011        001001
+ 000101      - 101100      + 010111
--------      --------      --------

  101101        011011        110010
+ 110110      - 101001      + 110111
--------      --------      --------
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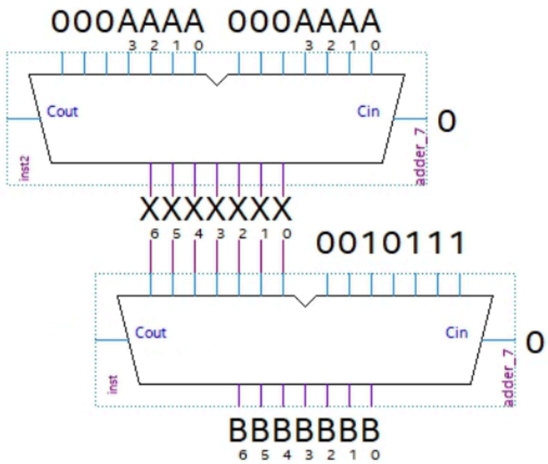
P3 (16 points): Let A be a three-bit unsigned number. Use a seven-bit adder (and NOT gates, as necessary) to design a circuit that calculates the following operations. Note that the output may be assumed as unsigned, unless it is possible for the operation to produce a negative answer, in which case, the output must be correct in 2's complement:

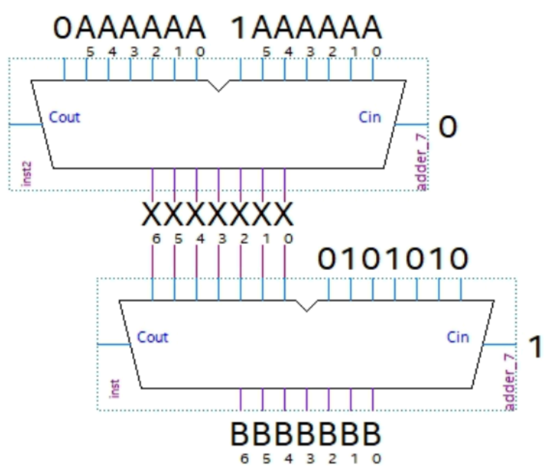
$W = 5A + 4$
$X = A - 14$
$Y = 34A + 18$
$Z = 38 - 4A$

P4 (18 points): In the circuits below, find the algebraic expression for **B(X)** (B in terms of X) and **X(A)** (the expression for X in terms of A). Overflow is ignored, but all results that would produce an overflow are not be accepted as an allowed input.

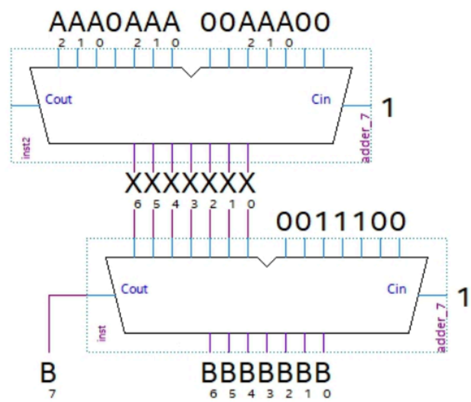
a) Here, A is a 4-bit unsigned integer, X is a 7-bit unsigned integer, and B is a 7-bit number in 2's complement.



b) X and B are 7-bit 2's complement integers, but A is a 6-bit unsigned integer.



c) A is a 3-bit unsigned integer, X is an unsigned 7-bit integer, and B is an 8-bit unsigned number. Hint: consider the role of B_7 when the value of X is large.



P5 (16 points): Convert the following numbers to IEEE 754 Single-Precision Floating Point format. Write your answer in **hexadecimal**, and indicate if an answer has a repeating mantissa:

a) -49
b) 250
c) 25/128
d) 3.3

P6 (8 points): Convert the following numbers from IEEE 754 Single-Precision Floating Point format to decimal. Note that each number is given in hexadecimal. You may leave the result as a fraction.

a) $C4000000_{16}$
b) $421C0000_{16}$
c) $BF700000_{16}$
d) $3F840000_{16}$

P7) (8 Points): Answer the following questions about MUXes and decoders.

a) How many 1-bit 2-to-1 MUXes are necessary to create an 8-bit 2-to-1MUX?
b) How many 1-bit 2-to-1 MUXes are necessary to create a 1-bit 8-to-1 MUX?
c) How many 2-to-4 decoders are necessary to create a 4-to-16 decoder?
d) How many 3-to-8 decoders are necessary to create a 6-to-64 decoder?

P8 (14 points): Implement the function $G(w,x,y,z) = \sum m(5,7,8,10,13,14,15)$ as follows:

a) Use a K-map to show that G can be written as $G = xz + w\bar{x}\bar{z} + wy\bar{z}$
b) Implement G using only a minimal number (3) of 2-1 MUXes and no other gates (NOT gates are not allowed, either). Hint: Use Shannon's Expansion Theorem a few times.