CprE 2810 HW06
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Representation and Arithmetic
Assigned: Week 7
Due Date: Oct. 14, 2024

P1 (8 points): Express -34_{10} in the following binary formats. If it is not possible simply write **Not Possible**. Indicate how many bits are needed.

a. Unsigned
b. Sign & Magnitude
c. 1's Compliment
d. 2's Compliment

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.

```
+000001     +001110     +111110
 011000      110001      111010
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-010000     -001011     -101100
 110111      101101      010100
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P3 (10 points) Draw the complete circuit diagram for a 2-bit ripple-carry adder. You are allowed to use 2-input and 3-input logical gates (of any type), but you can't use any higher-level abstractions (e.g., can't use half-adders or full-adders as black boxes in your circuit).

P4 (10 Points): You are given a 2-bit adder as a black box (say a microchip that you can't modify). The adder is too small for what you need to do and also does not compute an overflow bit. Draw a circuit that uses the 2-bit adder and any additional elements that you think are necessary to implement a 4-bit ripple-carry adder that also computes an overflow bit. Label all inputs, outputs and components.

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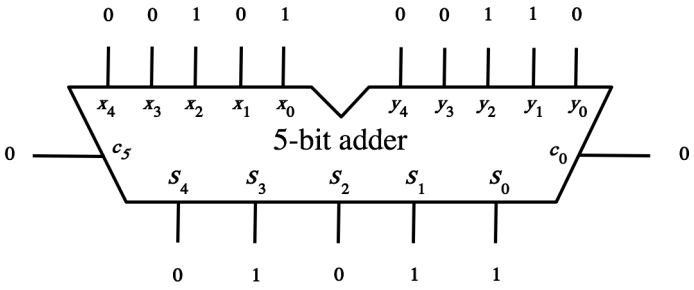
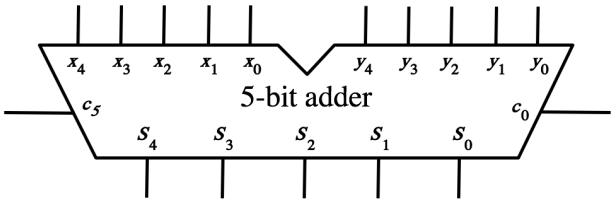
P5 (15 Points): In all problems below, the binary numbers are in 2's complement representation. Assign either a 0 or a 1 to each input and output of the 5-bit adder such that it computes the given expression. The problem in a) is already solved.

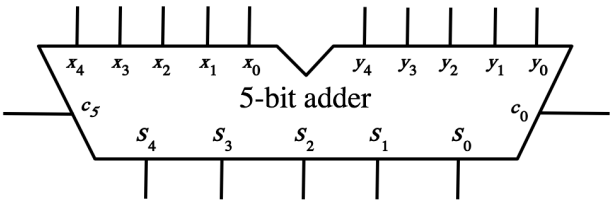
a) **(+5) + (+6) = +11**



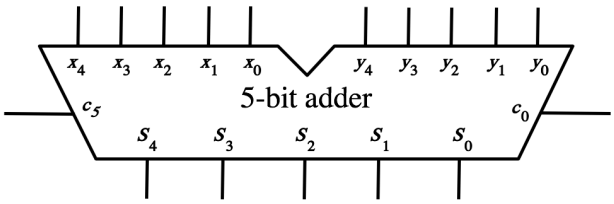
b) **(+8) + (+1) =**



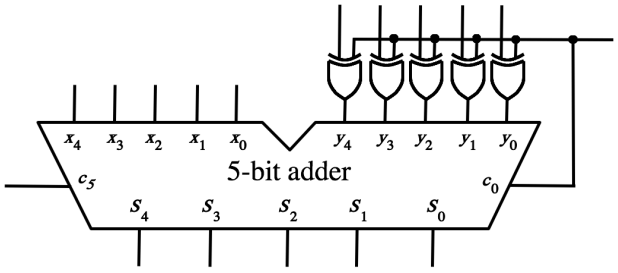
c) **(5) + (-15) =**



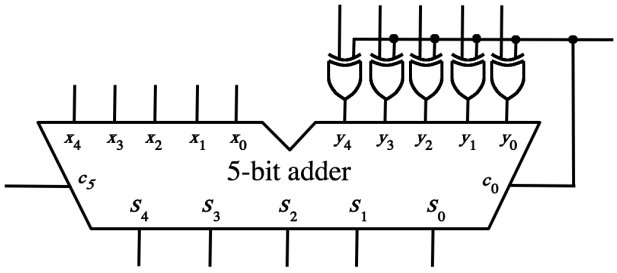
d) **(-12) + (-6) =**



e) **(+9) + (+10) =**



f) **(-10) - (-10) =**



P6 (15 Points): Perform the following multiplications using 2's complement binary numbers. Show all your work using **binary numbers**:

a. $100_2 * 001_2$

b. $1001_2 * 1111_2$

c. $10101_2 * 01010_2$

d. $-2_{10} * 7_{10}$

e. $15_{10} * 9_{10}$

P7 (15 points): Convert the following numbers to IEEE 754 Single-Precision Floating Point format. Write your answer as a 32-bit number. Show your derivations.

a) 52
b) -23
c) -81
d) 96
e) 111

P8 (15 points): Convert the following numbers from IEEE 754 Single-Precision Floating Point format to **decimal**. Show your derivations.

a) $01000001110110000000000000000000_2$
b) $11000010111000000000000000000000_2$
c) $C2810000_{16}$
d) 42860000_{16}
e) $C0DE0000_{16}$