CIS 240: **MICROCOMPUTER ARCHITECTURE & PROGRAMMING**

HW2: 2's complement and building with gates

1. 2's complement
   Fill in this table. Do row by row like we did in class. All answers need to be 8-bits.

Row #	Base-10	Positive binary	Hexadecimal	2's complement
①	-12_{10}	Can't do	0xF4	11110100_2
②	21_{10}	00010101_2	0x15	00010101_2
③	Can't do 132_{10} 128_{10}	10000100_2	0x84	10000100_2
④	-15	Can't do	0xF1	11110001_2
⑤	9	00001001_2	0x09	00001001_2

2. If you need more practice, find an on-line calculator for any of these representations and test yourself. Be careful with the 2's complement calculators. Some of them flip any number you put into the calculator. Look for one that's decimal to 2's complement like: https://www.exploringbinary.com/twos-complement-converter/

3. SOP (sum of product) from truth table. Find the logic for the digital circuit described by the following truth tables.

   a.

Inputs		Output
A	B	Out
0	0	0
0	1	1
1	0	0
1	1	1

b.

Inputs			Output
A	B	C	Out
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

$out = \bar{A} \cdot B \cdot C + A \cdot B \cdot \bar{C} + A \cdot B \cdot C$

$A=0, B=1, C=1$ ← $\bar{A} \cdot B \cdot C$

$A \cdot B \cdot \bar{C}$ ←

$A \cdot B \cdot C$ ←

c. Make a truth table that converts 3-bit thermometer code to binary. Thermometer code counts up:

$000_2 \rightarrow 001_2 \rightarrow 011_2 \rightarrow 111_2$

In thermometer code, $000_2=0_{10}$, $001_2=1_{10}$, $011_2=2_{10}$, and $111_2=3_{10}$.

HINT: In the truth table, any row not used can have an output of X (for don't care).

A	B	C	O_3	O_2	O_1
0	0	0	0	0	1
0	0	1	0	1	1
0	1	0	X	X	X
0	1	1	1	1	1
1	0	0	X	X	X
1	0	1	X	X	X
1	1	0	X	X	X
1	1	1	0	0	0

d. Find the logic for your thermometer code truth table.

$O_3 = \bar{A} \cdot B \cdot C$

$O_2 = \bar{A} \cdot \bar{B} \cdot C + \bar{A} \cdot B \cdot C$

$O_3 = \bar{A} \cdot \bar{B} \cdot \bar{C} + \bar{A} \cdot B \cdot C + \bar{A} \cdot B \cdot C$