CSCI 2150 – Binary Representations Homework

Name: ___________________________________

1. Fill in the blank cells of the table below with the correct numeric format. ***For cells representing binary values, only 8-bit values are allowed!*** If a value for a cell is invalid or cannot be represented in that format, write "X".

Decimal	2's complement binary	Signed magnitude binary	Unsigned binary
195	**X**	**X**	**11000011**
–76	**10110100**	**11001100**	**X**
-2	**11111110**	**10000010**	**X**
105	**01101001**	**01101001**	**01101001**

First row:

- 2's Complement and Signed Magnitude: Since the first digit of the unsigned binary value is a one, the number is outside the range of both of the signed representations, i.e., the sign bit is being used for magnitude. The largest positive value representable in both 2's complement and signed magnitude in 8 bits is $2^{(8-1)} - 1 = 127_{10}$. Therefore, X's should be placed in both of these fields.
- Decimal: Since unsigned binary is always a positive value, simply add the powers of 2 for each position that has a 1 in the unsigned binary representation: $2^7 + 2^6 + 2^1 + 2^0 = 128 + 64 + 2 + 1 = 195_{10}$.

Second row:

- Unsigned binary: Since the MSB of the 2's complement value is a one, it is a negative number and not representable in unsigned binary.
- Decimal: Since the value is negative, we need to first convert the 2's complement representation to its corresponding positive value to determine the magnitude. This is done by doing the "bit-flippy-thing". Starting with the LSB, copy all of the zeros up to and including the first 1. In this case, the three least significant bits will be copied. Inverting the remaining bits gives us the corresponding unsigned value. 01001100_2. Converting this to decimal gives us $2^6 + 2^3 + 2^2 = 64 + 8 + 4 = 76_{10}$. Therefore, the decimal value is $–76_{10}$.
- To convert $01001100_2 = 76_{10}$ to $–76_{10}$, simply invert the MSB to make the sign negative. This gives us 11001100_2.

Third row:

- Unsigned binary: Negative values cannot be represented in unsigned binary, so simply enter an X in the field.
- 2's complement: To convert to 2's complement, we first need to convert the absolute value of the decimal value to unsigned binary. This gives us 00000010_2. Now, we do the bit-flippy thing, which gives us 11111110_2.
- Signed magnitude: Inverting the first bit of 00000010_2 gives us 10000010_2 which is the signed magnitude value of –2.

Fourth row:

- Signed magnitude and 2's complement: Since the MSB of the unsigned binary value is set to 0, then all three binary representations are identical. Remember that positive numbers are represented the same way in all three representations unless the MSB is set to 1.
- Decimal: Since unsigned binary is always a positive value, simply add the powers of 2: $2^6 + 2^5 + 2^3 + 2^0 = 64 + 32 + 8 + 1 = 105_{10}$.

2. Convert $101011101101000100100011_2$ to hexadecimal.

To the right is a copy of the hexadecimal to binary conversion table. Simply partition the binary value above into nibbles starting on the right side. If the left most nibble was not a full four bits long, you would have needed to pad it with zeros added to the left side. Below is the partitioned binary value.

1010 1110 1101 0001 0010 0011

By replacing each nibble with its corresponding hexadecimal digit from the table, we get:

A E D 1 2 3

Binary	Hexadecimal
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9
1 0 1 0	A
1 0 1 1	B
1 1 0 0	C
1 1 0 1	D
1 1 1 0	E
1 1 1 1	F

3. Convert the binary value 110.0111 to decimal. (Note the binary point!)

Remember that binary digits to the right of the point continue in descending integer powers relative to the 2^0 position. Therefore, the powers of two are in order to the right of the point $2^{-1} = 0.5$, $2^{-2} = 0.25$, $2^{-3} = 0.125$, $2^{-4} = 0.0625$, and $2^{-5} = 0.03125$.

2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}
0	1	1	0	0	1	1	1	0

Therefore, the answer is: $2^2 + 2^1 + 2^{-2} + 2^{-3} + 2^{-4} = 4 + 2 + 1/4 + 1/8 + 1/16 =$ **6.4375**. You could have left your answer in any of these forms in order to receive full credit.

4. Convert the 32-bit floating-point number 11000010101001011100000000000000 to its binary exponential format, e.g., 1.1010110×2^{-12}, (which, by the way, is not even close to the right answer).

Begin by dividing up the floating-point number into its components.

S	E	F
1	10000101= 128 + 4 + 1 = 133	01001011100000000000000

Substituting into the expression $\pm 1.F \times 2^{(E-127)}$ gives us our answer.

$\pm 1.F \times 2^{(E-127)} = -1.010010111 \times 2^{(133-127)} = -1.010010111 \times 2^6 = -1010010.111 = -82.875$