# CS61C Fall 2018 GS Worksheet 1a Solution(Num Rep)

1. **Number Representation** (Spring 2017 MT1 #1)
   Consider a base-5 number format where the digits can take values 0, 1, 2, 3, 4:
   a. What is the largest number that can be represented as an unsigned base-5 number of N digits? Express your answer in terms of N.

      **$5^N - 1$**

   b. Convert $623_{10}$ to a number in base 5:

      **4443**

2. **Another Number Representation**
   a. Convert the following 8-bit two's complement numbers from hexadecimal to decimal:

      0x80 = -128
      0xF4 = -12
      0x0E = 14

   b. Assume that the most significant bit (MSB) of x is a 0. We store the result of flipping x's bits into y. Interpreted in the following number representations, how large is the magnitude of y relative to the magnitude of x? Circle ONE choice per row.

| | | | | |
|---|---|---|---|---|
| Unsigned | \|y\| < \|x\| | \|y\| = \|x\| | \|y\| > \|x\| | Can't Tell |
| One's Complement | \|y\| < \|x\| | \|y\| = \|x\| | \|y\| > \|x\| | Can't Tell |
| Two's Complement | \|y\| < \|x\| | \|y\| = \|x\| | \|y\| > \|x\| | Can't Tell |
| Sign and Magnitude | \|y\| < \|x\| | \|y\| = \|x\| | \|y\| > \|x\| | Can't Tell |
| | | | | |

- In unsigned, a number with the MSB of 1 is always greater than one with a MSB of 0.
- In one's complement, flipping all of the bits is the negation procedure, so the magnitude will be the same.
- In two's complement, y is a negative number. Its magnitude can be found by applying the negation procedure, which is flipping the bits and then adding 1, resulting in a larger magnitude than x.
- In sign and magnitude, the 2nd MSB bit will determine the relative magnitudes of x and y, so you can't tell for certain.

## 3 Back to the Base-ics (Fall 2017 MT1 #1)

a) Show how the binary string 0b1011 0110 can be interpreted and displayed as the following types:

Hexadecimal: 0x_____B6_____

Unsigned Decimal: _____182_____

Two's Complement Decimal: _____ -74_____

b) What is the minimum number of bits needed to represent all the unsigned integer values that a three-digit base-7 number could encode? Your answer should be a simplified decimal value.

Powers of 7 are shown below for reference:
7^1 = 7
7^2 = 49
7^3 = 343
7^4 = 2401
7^5 = 16807

_____9_____

c) What bias should be added for a biased three-digit base-7 number to yield an equal number of positive and negative numbers? Your answer should be a simplified decimal value.

_____-171_____

d) Convert the unsigned number 0xDF to its base-7 equivalent (i.e. the base-7 number with the same decimal value). What is the resulting number? The prefix 0s is for base-7.

_____436_____

**4. Num Rep!**
Answer the following questions about number representation:

**(a) Unsigned Base 4**

(i) What is the range that a 4 digit unsigned base 4 number can represent? Write the bounds in decimal.

Solution: 0000(base 4) ~ 3333 (base 4)= 0 ~ 255

(ii) Convert 107(base 10) to unsigned base 4.

Solution: 107(base 10) = 64 + 16 * 2 + 4 * 2 + 3 = 1223(base)

**(b) Signed Base 4**

(i) Suppose we wanted to use a bias in order to represent negative numbers in base 4. If we are working with a 4 digit base 4 number, what should we choose as our bias?
(Our bias should create equal amounts of negative and positive numbers for our range. If this is not possible, select a bias that will result in 1 more negative number than positive numbers).

Express your answer in decimal.

Solution: 255/2 = 127. So the bias is -128 to favor negative numbers.

(ii) Suppose rather than using a bias notation, we decide to do the following. For each base 4 number, we will reserve the most significant digit to strictly be used as a sign bit. A digit value of 1 will indicate a negative number, and a digit value of 0 will indicate a positive number. Any other values will result in an invalid number.

For instance: 00034 = +3  10034 = −3  20034 = Invalid

How many valid representation can we represent with a 4 digit base 4 number using this scheme?

Solution: 2*4*4*4 = 128