CS 255 (Fall 2022)
Assignment 2: Number Systems
Due: 9/27/22 (11:59pm)

Show all of your work for each problem below. Wherever data types are mentioned, assume that a `char` is 1 byte, a `short` is 2 bytes and an `int` is 4 bytes.

1. Computer X uses (an illogical format of) 3-byte integers (i.e. each integer consists of 3 bytes) and each byte consists of 8 bits. It uses the two's complement number system to represent signed integers.

   (a) (5 pts.) How many different patterns can be used to store a word?

   (b) (10 pts.) What are the two's complement representations for the values 2701282 and -2701282 in computer X?

   (c) What signed decimal values are represented by the following hexadecimal patterns in computer X? (Hint: First convert from hexadecimal to binary)

      i. (3 pts.) 4D 7A A5

      ii. (3 pts.) FD 60 78

   (d) (9 pts.) Convert the two patterns in (c) to binary and then sum them together. What is the result in hexadecimal? What decimal value is represented by this pattern?

2. Do the following arithmetic in binary (representing unsigned integers). Show complete "tail" work (demonstrated in lecture notes) for full credit.

   (a) (10 pts.) $1001101_2 + 111001_2$

   (b) (10 pts.) $101101_2 * 1001_2$

   (c) (5 pts.) What is the minimum datatype that can store each of the results from the previous two calculations?

3. (10 pts.) Do the following arithmetic in base-5. Give complete "tail" multiplication to get full credit.

$$4302_5 * 2432_5$$

4. (15 pts.) After the following line of code, what value is stored in `x`? Show how you arrive at your answer through calculations in binary.

```
char x = 'C' * 'S';
```

5. Show how each of the following look in memory. Draw a diagram of the memory array large enough, and fill in what each byte contains in binary.

   (a) (5 pts) The string "Help!" (Assume 8 bit ASCII characters.)

   (b) (5 pts) The hexadecimal number AED6.

   (c) (5 pts) The signed integer -172 (in 16 bits) in two's complement format

   (d) (5 pts) The single precision floating point number 14.7