CSE 30: Computer Organization and Systems Programming Fall 2021

Assignment 4

Instructors: Bryan Chin, Keith Muller **Due on:** Sun Oct. 24 *(50 points)*

Name: _____ Date: _____

Instructions

- Answer each problem in the boxes provided. Any writing outside of the boxes will NOT be graded. Do not turn in responses recorded on separate sheets.
- Be sure to show your work on questions that say "Show work." Answers without relevant work will not receive credit.
- Handwritten or typed responses are accepted. In either case, make sure all answers are in the appropriate boxes. Here is a link for scanning:
  `http://gradescope-static-assets.s3-us-west-2.amazonaws.com/help/submitting_hw_guide.pdf`
- All responses must be neat and legible. Illegible answers will result in zero points.

Binary

1. (5 points **- Correctness**) *Bases*

   Creepers have four legs and a head. In order to better hunt down Minecraft players and ruin their creations, a group of creepers has literally put their heads together and decided they need to learn how to count for the little remainder of their lives. It could be the difference between death and... well, death by explosion. What is decimal 96 in base 5?

2. (5 points **- Correctness**) *Bases*

   Inspired by the creepers' efforts, and wanting to do better, the spiders have decided to come up with their own counting system. Naturally, they use a base-8 system. To defend yourself from their efforts, you need to learn to understand their numbers.
   In place of the digits `0 1 2 3 4 5 6 7`, they use the symbols: `$ % ( ) & ! @ *`, respectively.
   What is the spider-number `%)@$` in decimal?

3. (5 points **- Correctness**) *Binary and hexadecimal conversions*

   (a) What is the binary number `1101100111001000` in hexadecimal? (Prefix your answer with 0x and use lowercase letters.)

   (b) Convert the following hexadecimal number to binary: `0xb0deface` (use only "1"s and/or "0"s in your answer, with underscores between every 4 digits, e.g. `1111_0000_1010_0101`).

4. (10 points **- Correctness**) *2's complement*

   (a) For the 2's complement representation, what is the maximum positive number (in decimal) that can be represented in a 11 bit wide field? (Since the number is assumed to be positive, please leave out the "+".)

   (b) Assuming an 8-bit 2's complement representation, add the following two binary numbers (in binary) and express the answer in signed decimal format (i.e. prefix your answer with a + or -). **Show your work!**

```
  00001111
+ 11101110
----------
```

   (c) Assuming a 5-bit unsigned representation, multiply the following two binary numbers (in binary) to generate an unsigned 10 bit answer and express this answer in unsigned decimal format. **Show your work!**

```
  11101
x 01001
-------
```

5. (5 points **- Correctness**) *Overflow*
   Check all of the following that will **not** overflow in a 4 bit field (assume 2's complement arithmetic):

   ☐ 0111 + 0101

   ☐ 1010 + 1001

   ☐ 1111 + 0111

   ☐ 1110 + 1101

6. (10 points **- Correctness**) *Fixed point numbers*

Assuming a fixed point representation of 10 bits with the radix point positioned exactly in the middle (for example 0 would be represented as 00000.00000), how would one write the unsigned decimal fraction 229/32 in binary? Note: express numerator and denominator in binary and then divide. **Show your work!**

7. (10 points **- Correctness**) *Floating point numbers*

   (a) The spiders are at it again! They're using the 8-bit floating point representation, as shown in lecture, to communicate more precise numbers with each other. If you learn to convert your decimal to their 8-bit representation, you'll figure out their plans before they attack. Convert -4.75 to an 8 bit floating point representation as shown in lecture. (In other words, what is the 8 bit floating point equivalent of this decimal value?) Write your answer in binary. **Show your work, include the sign bit, exponent, and mantissa!**

(b) You don't want those spiders to get the upper hand, or leg, on you, so you need to learn to convert from hex back to decimal too. Convert the 8-bit floating point number `0xE8` to its decimal equivalent. Assuming a floating point representation of 8 bits as shown in lecture, what is the decimal equivalent? **Show your work!**