Homework 1

Integer and Floating Point Number Representations

Integer

Some modern processors, such as the DEC Alpha (now owned by Intel), have a 64 bit (instead of 32 bit) two's complement integer format. For this section of the homework, assume such a format.

Problem 1

Suppose you have a 3 GHz processor and you can execute a 64 bit integer addition every two cycles. How long will the following loop run?

```
long int i;  /* 64 bit integer */
for (i=-1L;i<0;i++) {}
```

Problem 2

A Full Adder (FA) logic block takes three input bits and provides two output bits. The input bits are summed to produce a two bit output. Write a table showing what each combination of input bits produces at the output. Draw a picture of how you might connect FAs together to create a (slow) 64 bit adder. If you're interested in how a *fast* adder works, do a google search for the term "carry lookahead adder".

Problem 3

Some instruction sets, including x86, provide an integer representation in addition to two's complement. This representation is called Binary Coded Decimal (BCD). How many unique numbers can be represented in a 64 bit BCD quantity? Why might one use BCD?

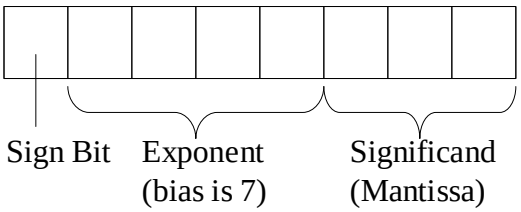
Problem 4

Most instruction sets provide an "add with carry" and a "subtract with borrow" instruction. Explain how you might use these to implement arbitrary bit length integer representations. Are the instructions necessary to do this?

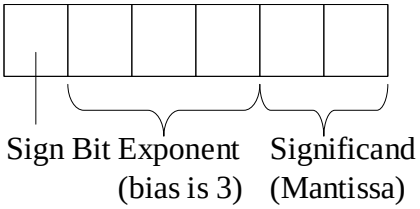
Floating Point

Consider the following two small floating point formats based on the IEEE standard:

- Little Format



- Tiny Format



Except for the sizes of these formats, the rules are those of the IEEE standard.

Problem 1

For both formats, determine the following values (in decimal)

1. Largest positive finite number
2. Positive normalized number closest to zero
3. Largest positive denormalized number
4. Positive denormalized number closest to zero

Problem 2

Encode the following values in the 8 bit Little Format: ¾, -13/16, 44, and –104, show each in binary and hexadecimal.

Problem 3

Determine the values corresponding to the following Little Format bit patterns. The leftmost bit is the most significant

1. 10110011
2. 01111010
3. 10010001
4. 01001111
5. 11000001

Problem 4

Convert the following 8 bit Little Format numbers into 6 bit Tiny Format numbers. Overflow should yield +/- infinity, underflow should yield +/- 0.0, and rounding should follow the “round-to-nearest-even” tie-breaking rule.

1. 00010000
2. 11101000
3. 00110011
4. 11001110
5. 11000101