## CMPT 295 Assignment 5 Solutions (2%)

## 1. [7 marks] Floating-Point Integers

Just to show the significance, the percentage of the code that applies to each part is included.

- (a) [1 mark] There are  $106 \cdot 2^{23}$  positive integers (including +0), and an equal number of negative integers. (41.4% of all floating point)
- (b)  $[1 \text{ mark}] 2^{24} 1 (= 16777215).$
- (c)  $[1 \text{ mark}] 2^{128} 2^{104}$ , and  $2^{128} 2^{105}$ .
- (d) [1 mark] The consecutive integers fall in the range  $[-2^{24}, 2^{24}]$  and there are  $2^{25} + 1$  (= 33554433) of them. (0.78% of all floating point)
- (e)  $[1 \text{ mark}] \ 2^{32} = 1.000\ 0000\ 0000\ 0000\ 0000\ 0000\ \times 2^{32}$ . The nearest neighbours would therefore be  $1.000\ 0000\ 0000\ 0000\ 0000\ 0001\ \times 2^{32} = 2^{32} + 2^{9}$  and  $1.111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111$
- (f) [2 marks] There are  $10 \times 2^{23}$  positive integers (again including +0) that are less than  $2^{32}$ . (2.0% of all floating point, 4.7% of S)

## 2. [2 marks] Floating-Point Addition

• These are  $+1.001~0011~1000~0000~0000~0000_2 \times 2^8$  and  $-1.010~1000~0000~0000~0000~0000_2 \times 2^5$ . To subtract their magnitudes, the latter must be shifted right by 3 places, because the difference in the exponents is 3.

Thus we have a positive number (sign bit = 0), with a normalized significand of 1.111 1101 and a normalized exponent of  $2^7$ . This encodes as 0x437d0000.

• These are  $+1.001\ 1001\ 1001\ 1001\ 1001\ 1010_2 \times 2^{-1}$  and  $1.100\ 1100\ 1100\ 1100\ 1100\ 1101_2 \times 2^{-2}$ . Again, alignment must occur before adding: this time it is shifted by one place.

The resulting significand is too long, so it must be truncated and rounded. Since the 25<sup>th</sup> significant digit is 0, the result is rounded down. The result is  $10_2 \times 2^{-1} = 1 \times 2^0$ , or 0x3f800000.