CMPUT 229 (A1) - Quiz # 5 - Fall 2013

Name: Solution

The following is a format for the binary representation of a floating-point number:

10	9		5	4		0
S		exponent			fraction	

The exponent is expressed in excess-8 format (also known as a bias representation). Given the binary representation above, the decimal value of the number represented can be computed by the following expression:

$$
N = \begin{cases}
0.0 & \text{if } exponent = 0 \text{ and } fraction = 0 \\
(-1)^S \times 0.fraction \times 2^{-14} & \text{if } exponent = 0 \text{ and } fraction \neq 0 \\
(-1)^S \times 1.fraction \times 2^{exponent-15} & \text{if } 0 < exponent < 30 \\
(-1)^S \times \infty & \text{if } exponent = 31 \text{ and } fraction = 0 \\
NaN & \text{if } exponent = 31 \text{ and } fraction \neq 0
\end{cases}
$$

1. (30 points) Let $X = 64_{10}$. Give the normalized binary representation for X and the bit pattern for the representation of X in this notation.

$64_{10} = 2^6 = 1.0 \times 2^6 \Rightarrow exponent - 15 = 6 \Rightarrow exponent = 21$

10	9		5	4		0
0		10101			00000	

2. (30 points) Let $Y = 5.25_{10}$. Give the normalized binary representation for Y and the bit pattern for the representation of Y in this notation.

$5.25_{10} = 2^2 + 2^1 + 2^{-2} = 101.01 = 1.0101 \times 2^2 \Rightarrow exponent - 15 = 2 \Rightarrow exponent = 17$

10	9		5	4		0
0		10001			01010	

3. (40 points) If this machine has an adder with a round bit, a guard bit, and a *sticky* bit, what is the value of $X + Y$ computed by this machine? Give both the normalized binary notation and the decimal value.

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          Mantissa   Guard Round    Sticky      exponent

X   =     1.00000      0     0         0            6

Y =       0.00010      1     0         1            6

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X+Y =     1.00010      1     0         1            6
```

With the sticky bit equal 1 we must round up:

$$
\begin{aligned}
X + Y &= 1.00011 \times 2^6 \\
X + Y &= 1000110 = 2^6 + 2^2 + 2^1 = 64 + 4 + 2 = 70
\end{aligned}
$$