EE 3755, Fall 2010

Homework #1 solutions

10pts [redacted] HW#1 solution 1

$\boxed{1}$ Here the numbers 37, 55 X, Y are of different signs. Therefore, we have to perform the subtraction

(magnitude of X) − (magnitude of Y) =

$(1011011)_2 - (1101001)_2 =$

$= (1011011) +$ 2's compl. of (1101001)

$$
\begin{array}{r}
= \; 1011011 \\
+) \; 0010111 \\
\hline
0\;1110010
\end{array}
$$

$\hookrightarrow c = 0 \Rightarrow$ result $< 0 \Rightarrow$ (mag. of X) − (mag. of Y) < 0

$\Rightarrow$ mag. of X $<$ mag. of Y

So sign bit of result = sign bit of Y = 1

and magnitude of X+Y =

= 2's compl. of (1110010) = 0001110

Thus, $X+Y = (10001110)_2 = (-14)_{10}$

2 → 20pts HW #1 solution (3755) ②

B	A	d
0000000	100101	0

Initialization

+) 1101110

↳ 010 ⇒ add 1 × multiplicand / double right shift

1101110	100101	0
11111011	101001	0

↳ 010 ⇒ add 1 × multiplicand / double right shift

+) 1101110

11101001	101001	0
11111010	011010	0

↳ 100 ⇒ add −2 × multiplicand / double right shift.

0100100

00111110	011010	0
0000111	100110	1

⟹ product =

$(000111\ 100110)_2 = (486)_{10}$

$= (-18) \times (-27)$

3755 HW#1 solution

$\boxed{3}$ → 20 pts

C	R	Q	
$\boxed{X}$	01010	10001	Initialization
	10101	0001	shift left / subtract B
$\boxed{1}$	10011		
	01000	00011	
	10000	0011	shift left / subtract B
$\boxed{1}$	10011		
	00011	00111	
	00110	0111	shift left / subtract B
$\boxed{0}$	10011		
	11001	01110	
	10010	1110	shift left / add B
$\boxed{0}$	01101		
	11111	11100	
	11111	1100	shift left / add B
	01101		
$\boxed{1}$			
	01100	11001	* Restore is not needed

$R = (01100)_2 = 12$

$Q = (11001)_2 = 25$

$\boxed{4}$ → 20pts

C	R	Q	
X	01010	00011	Initialization
			shift left/subtr. B
	10100	0011	
1	10011		
	00111	00111	
			shift left/subtr. B
	01110	0111	
1	10011		
	00001	01111	
			shift left/subtr. B
	00010	1111	
0	10011		
	10101	11110	
			shift left/add B
	01011	1110	
0	01101		
	11000	11100	
			shift left/add B
	10001	1100	
0	01101		
	11110	11000	
			restore; (ie add B)
	01101		
	01011	11000	

$R = (01011)_2 = 11$

$Q = (11000)_2 = 24$

$\boxed{5} \rightarrow 10pt$ 3755 HW#1 solution

The range of the fraction (5)

is $\boxed{0.5 \le f \le 1 - 2^{-48}}$

The range of the exponent is

$-2^{10} \le e \le 2^{10} - 1$ or $\boxed{-1024 \le e \le 1023}$

So the positive dynamic range is

$$\boxed{0.5 \times 2^{-1024} \le A^{+} \le (1 - 2^{-48}) \times 2^{1023}}$$

The negative dynamic range is

$$\boxed{-(1 - 2^{-48}) \times 2^{1023} \le A^{-} \le -0.5 \times 2^{-1024}}$$

20pts

$\boxed{6}$ 1. Align/adjust

$e_1 - e_2 = e_1 + 2\text{'s}$ complement of $e_2 =$

$$
\begin{array}{r}
= \ 0111 \\
+) \ 0111 \\
\hline
0\ 1110
\end{array}
$$

$\hookrightarrow c = 0 \Rightarrow e_1 - e_2 < 0 \Rightarrow e_1 < e_2$ and

$e_2 - e_1 = 2\text{'s}$ compl. of $(1110) = (0010)_2 = (2)_{10}$

Thus A_1 becomes

	s_1	e_2	f_1'
A_1:	0	1001	00111100

2. Subtract fractions

Since A_1 and A_2 are of different signs and $A_1 + A_2$ needs to be performed, a subtraction must take place.

$f_1' - f_2 = f_1' + 2\text{'s}$ complement of $f_2 =$

$$
\begin{array}{r}
= \ .00111100 \\
+) \ .01101110 \\
\hline
0.10101010
\end{array}
$$

$\hookrightarrow c = 0 \Rightarrow f_1' - f_2 < 0 \Rightarrow f_1' < f_2$

Since f_2 is the larger fraction, the result $A_3 = A_1 + A_2$ must have as a sign bit the sign bit of A_2 (negative sign)

The fraction of $A_3 = A_1 + A_2$ will be the 2's compl. of $(10101010) = 01010110$

Therefore

A_3 : | 1 | 1001 | 01010110 |

3. Postnormalize

After postnormalization we get

	s_3	e_3	f_3
A_3 :	1	1000	10101100

4. Check for exponent underflow

No exponent underflow occured

See that $e_3 = (1000)_2 = 8 \in [0 \quad 15]$