EE 3755, Fall 2011

Homework #1 solutions

[1] Here the numbers $^{37}X, ^{55}Y$ 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)

$= 1011011$

$+) \; 0010111$

$0\,1\,1\,1\,0\,0\,1\,0$

↳ $c=0 \Rightarrow$ result $< 0 \Rightarrow$ (mgg. of X) − (mgg. of Y) < 0

$\Rightarrow$ mgg. of X < mgg. 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 [redacted] HW #1 solution (3755) (2)

B	A	d
0000000	100101	0

Initialization

+) 1101110

↳ 010 ⇒ add 1 x multiplicand
double right shift

1101110	100101	0
1111011	010010	0

↳ 010 ⇒ add 1 x multiplicand
double right shift

+) 1101110

1101001	101001	0
1111010	011010	0

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

01001100

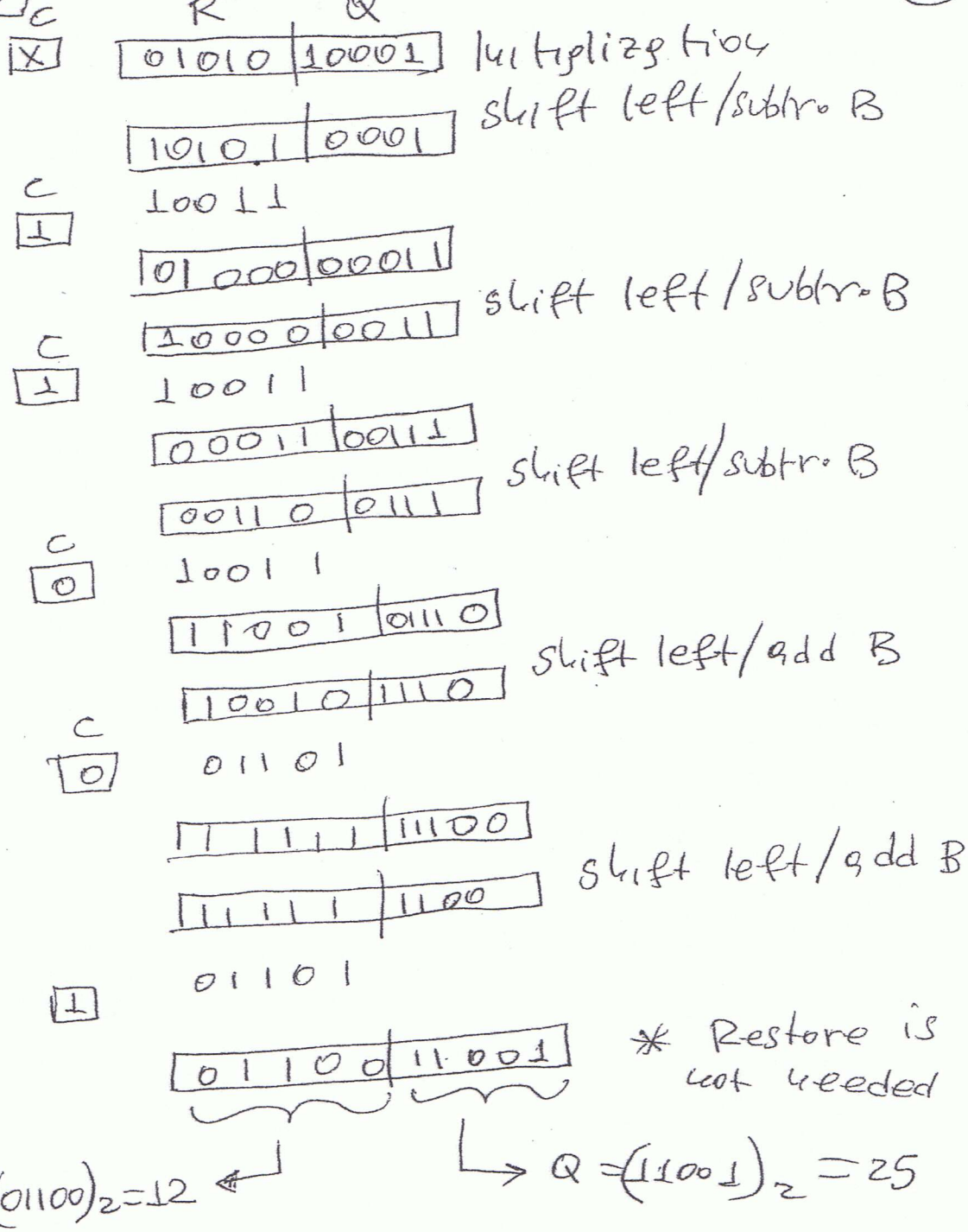
0011110	011010	0
0000111	100110	1

⟹ product =

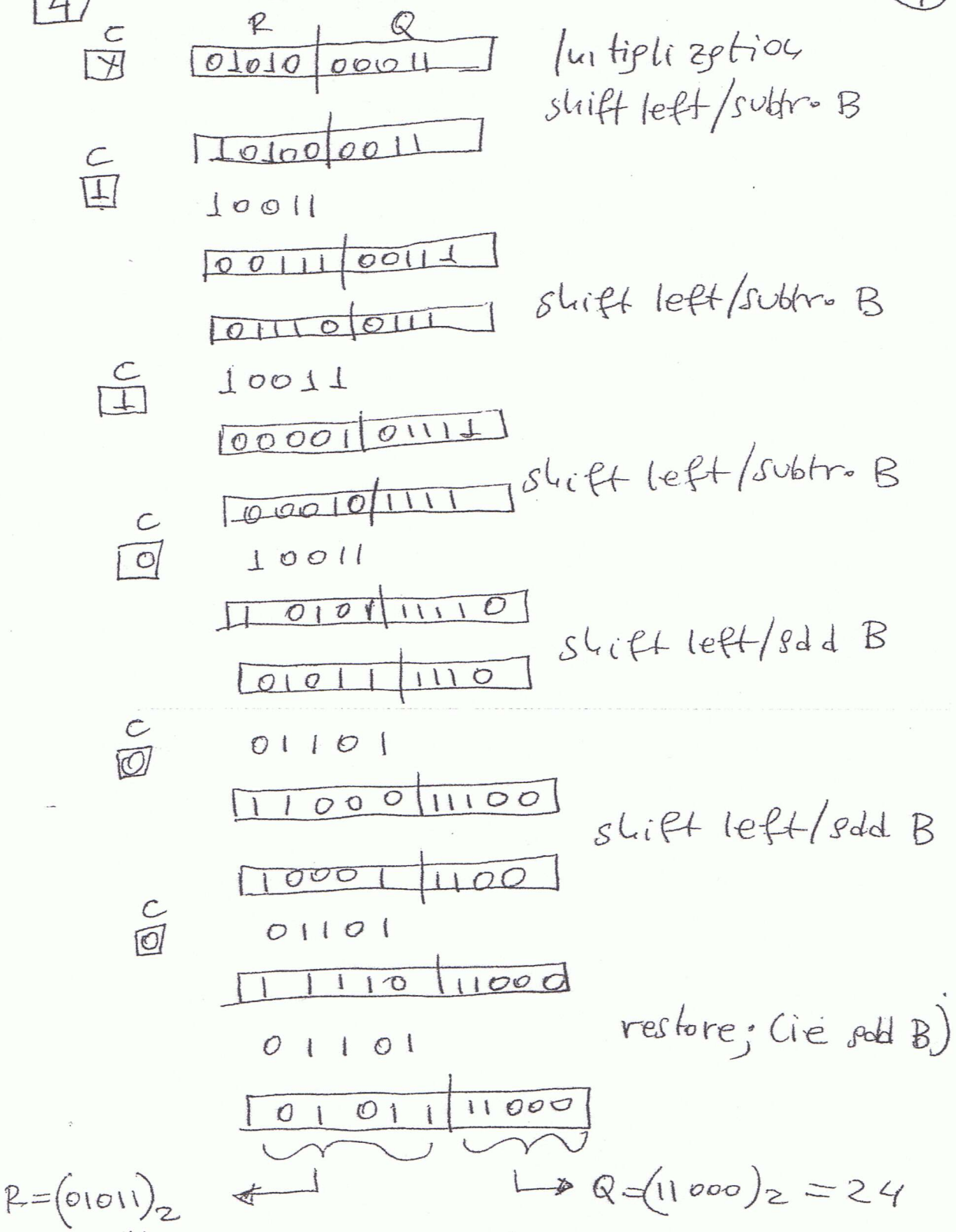
$(000111\ 100110)_2 = (486)_{10}$

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

3


C
R
Q
X
01010 | 10001
Multiplication
shift left/subtr. B
10101 | 0001
C
1
10011
01000 | 0001
shift left/subtr. B
10000 | 0011
C
1
10011
00011 | 0011
shift left/subtr. B
00110 | 0111
C
0
10011
11001 | 0110
shift left/add B
10010 | 1110
C
0
01101
11111 | 1100
shift left/add B
11111 | 1000
01101
1
01100 | 11001
* Restore is not needed
R=(01100)2=12
Q=(11001)2=25

4


C
R
Q
multiplication
shift left/subtr. B
shift left/subtr. B
shift left/subtr. B
shift left/add B
shift left/add B
restore; (i.e. add B)
R=(01011)2
=11
Q=(11000)2=24

5 The range of the fraction is $0.5 \le f \le 1 - 2^{-48}$ (5)

The range of the exponent is

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

So the positive dynamic range is

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

The negative dynamic range is

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

6 1. Align/adjust

$e_1 - e_2 = e_1 + 2$'s complement of $e_2 =$

$= 0111$

$+) \ 0111$

$0 \ 1110$

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

$e_2 - e_1 = 2$'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.

$f_1' - f_2 = f_1' + 2$'s complement of $f_2 =$

$= \ .00111100$

$+) \ .01101110$

0.10100010

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

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

A_3:

s_3	e_3	f_3
1	1000	10101100

4. Check for exponent underflow

No exponent underflow occured
See that $e_3 = (1000)_2 = 8 \in [0 \quad 15]$