EEE-4024: Computer Architecture Organization

Digital Assignment 1

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(19BEE0330)

(1) Find the product of 9 * 14 by multiple algorithm.

A = 9 → 1001 (Multiplicand)
B = 14 → 1110 (Multiplier)

$$
\begin{array}{r}
1\,0\,0\,1 \\
\times\ 1\,1\,1\,0 \\
\hline
0\,0\,0\,0 \\
1\,0\,0\,1 \\
1\,0\,0\,1 \\
+\ 1\,0\,0\,1 \\
\hline
1\,1\,1\,1\,1\,1\,0
\end{array}
$$

	E	A	Q	Sc	
	0	0000	1110	100	(4)
$B_n = 0$ Shr EAQ	0	0000	0111	011	(3)
$B_n = 1$ Add A+B		+1001			
	0	1001	0111		
Shr EAQ	0	0100	1011	010	(2)
$Q_n = 1$ Add A+B		+1001			
	0	1101	1011		
Shr EAQ	0	0110	1101	001	(1)
$Q_n = 1$ Add A+B		+1001			
	0	1111	1101		
Shr EAQ	0	0111	1110	000	(0)

(2) Booth Algorithm A = 11 B = -13

A = 11 → 01011

B = -13 → 01101 → 10010 + 1 = 10011

Multiplicand = M = 01011

−M = 10100 + 1 = 10101

Multiplier = Q = 10011

	A	Q	Q-1	SC
	00000	10011	0	5
10 → A−M	+10101			
	10101	10011		
Shr AQQ-1	11010	11001	1	4
11 → Shr AQQ-1	11101	01100	1	3
01 → A+M	+01011			
	01000	01100	1	
Shr AQQ-1	00100	00110	0	2
00 → Shr AQQ-1	00010	00011	0	1
10 → A−M	+10101			
	10111	00011	0	
Shr AQQ-1	11011	10001	1	0

$(11011\,10001)_2$

2's compliment → $(11011110001)_2$

1's compliment → $(11011110000)_2$

→ $(00100001111)_2$

$= 2^7 + 2^3 + 2^2 + 2^1 + 2^0$

$= -143$

$11 \times (-13) = -143$

(3) Division Algorithm

dividend = 17, divisor = 04

$(17)_{10} = (10001)_2$ M = 00100

$(4)_{10} = (00100)_2$ $\bar{M}+1$ = 11100

n	M	A(rem)	Q (Quo)
5	00100	00000	10001
	00100	00001	00011
	00100	11101	00010
	00100	11101	00100
4	00100	00001	00101
	00100	00010	00110
	00100	11110	00110
	00100	11110	00100
3	00100	00010	00100
	00100	00100	01100
	00100	00000	01000
2	00100	00000	01001
	00100	00000	10010
	00100	11100	10010
	00100	11100	10010
1	00100	00000	10010
	00100	00001	00101
	00100	11101	00101
0	00100	11101	00100
	00100	00001	00100

4. a = 0.75 b = -0.355

Addition Subtraction floating point numbers

0.75 + (-0.355) Addition

Convert to Binary

0.75 x 2 = 1.5(1) 0.355 x 2 = 0.71 (0)

0.5 x 2 = 1.0 (1) 0.71 x 2 = 1.42 (1)

= 0.11000 0.42 x 2 = 0.84 (0)

= 1.1 x 2^{-1} 0.84 x 2 = 1.68 (1)

= 1.1000 x 2^{-1} = 0.0101

= 0.1010 x 2^{-1}

A = 00000 1.1000

B = - 0.0001 010

.1111 0101

\+ 1

1111 0110

00001.0000

\+ 1111 0110

0000 1110

00000.1110 x 2^{-1} = 0.01110

Subtraction

0.75 - (-0.355) = 0.75 + 0.355

0.75 = 0.1100 = 1.1 x 2^{-1}

0.355 = 0.0101 = 0.101 x 2^{-1} = 0.1010 x 2^{-1}

0001 1000

0000 1010

= 1.0010

(5) Floating point multiplication for operands (0.22 * 0.145)

~~0.22 x 2 = 0.44 = 0~~

$0.22 \times 2 = 0.44 = 0$	$0.145 \times 2 = 0.29 = 0$
$0.44 \times 2 = 0.88 = 0$	$0.29 \times 2 = 0.58 = 0$
$0.58 \times 2 = 1.76 = 1$	$0.58 \times 2 = 1.16 = 1$
$0.76 \times 2 = 1.52 = 1$	$0.16 \times 2 = 0.32 = 0$
$0.52 \times 2 = 1.04 = 1$	$0.32 \times 2 = 0.64 = 0$
$0.04 \times 2 = 0.08 = 0$	$0.64 \times 2 = 1.28 = 1$

$(0.22)_{10} = (0.001110)_2$

$= 1.110 \times 2^{-3}$

$(0.145)_{10} = (0.001001)_2$

$= 1.001 \times 2^{-3}$

$-3 - 3 = -6$

```
    1.110
  x 1.001
  -------
    1110
   0000
  000000
 1110000
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1.111110 x 2^-6
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$(0.0319)_{10} = (0.000001111111)_2$