作业 4

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1 (6.19)：字长为 8 位（含一位符号位），用补码计算下列各题：

1. $A = \frac{9}{64}, B = -\frac{13}{32}, A + B$
2. $A = \frac{19}{32}, B = -\frac{17}{128}, A - B$
3. $A = -\frac{3}{16}, B = \frac{9}{32}, A + B$
4. $A = -87, B = 53, A - B$
5. $A = 115, B = -24, A + B$

解：

1. $A = 0.0010010; B = 1.1001100$

   $A + B = 1.1011110 = -\frac{17}{64}$
2. $A = 0.1001100; B = 1.1101111, -B = 0.0010001$

   $A - B = 0.1011101 = \frac{93}{128}$
3. $A = 1.1101000; B = 0.0100100$

   $A + B = 0.0001100 = \frac{3}{32}$
4. $A = -87 = 1,0101001; B = 53 = 0,0110101, -B = 1,1001011$

   $A - B = 0,1110100 = 116$
5. $A = 115 = 0,1110011; B = 1,1101000$

   $A + B = 0,1011011 = 91$

2 (6.20)：用原码一位乘、两位乘、补码一位乘计算 $x \cdot y$

1. $x = 0.110111, y = -0.101110$
2. $x = -0.010111, y = -0.010101$
3. $x = 19, y = 35$
4. $x = 0.11011, y = -0.11101$

解：

1. 符号位 $0 \oplus 1 = 1$

   a. 原码一位乘

      $z_0 = 0$

      $z_1 = z_0 \gg 1 = 0$

$z_2 = (z_0 + x) \gg 1 = 0.0110111$

$z_3 = (z_2 + x) \gg 1 = 0.10100101$

$z_4 = (z_3 + x) \gg 1 = 0.11000001$

$z_5 = z_4 \gg 1 = 0.011000001$

$z_6 = (z_5 + x) \gg 1 = 0.10011110001$

$x \cdot y = 1.10011110001$

b. 原码两位乘

设乘数以及 C_j 为 α

$z_0 = 0, \alpha = 100$

$z_1 = 000.01101110, \alpha = 110$

$z_2 = 111.1110010010, \alpha = 101$

$z_3 = 111.110000100010, \alpha = 001$

$z_4 = 000.100111100010$

$x \cdot y = 1.100111100010$

c. 补码一位乘

$[x]_{补} = 00.110111, [y]_{补} = 11.010010, [-x]_{补} = 11.001001$

令 $\alpha = y_n y_{n+1}$

$z_0 = 0, \alpha = 00 \Rightarrow z_1 = z_0 \gg 1$

$z_1 = 0, \alpha = 10 \Rightarrow z_2 = (z_1 - x) \gg 1$

$z_2 = 11.1001001, \alpha = 01 \Rightarrow z_3 = (z_2 + x) \gg 1\ x_0 = 00.0110111$

$z_3 = 00.00110111, \alpha = 00 \Rightarrow z_4 = z_3 \gg 1$

$z_4 = 00.000110111, \alpha = 10 \Rightarrow z_5 = (z_4 - x) \gg 1$

$z_5 = 11.1001111111, \alpha = 01 \Rightarrow z_6 = (z_5 + x) \gg 1$

$z_6 = 00.00111101111, \alpha = 10, z_7 = z_6 - x$

$z_7 = 11.01100001111$

$x \cdot y = 1.01100001111$

2. a. 原码一位乘

$|x| = 0.010111, |y| = 0.010101, S = 1 \oplus 1 = 0$

$0.000000 \quad 0.01010\underline{1}$

$0.001011 \quad 1|0.0101\underline{0}$

$0.000101 \quad 11|0.010\underline{1}$

$0.001110 \quad 011|0.01\underline{0}0$

$0.000111 \quad 0011|0.0\underline{1}$

$0.001111 \quad 00011|0.\underline{0}$

$0.000111 \quad 100011|0$

$[x \cdot y]_{原} = 0.000111100011$

b. 原码两位乘

$|x| = 00.010111, |y| = 0.010101, S = 1 \oplus 1 = 0$

$$
\begin{array}{rl}
00.000000| & 00.0101\underline{01 \quad 0} \\
+00.010111 & \gg 1 \\
00.000101 & 11|00.01\underline{01 \quad 0} \\
+00.010111 & \gg 1 \\
00.000111 & 0011|00.\underline{01 \quad 0} \\
+00.010111 & \gg 1 \\
00.000111 & 100011|00.
\end{array}
$$

$x \cdot y = 0.000111100011$

c. 补码一位乘

$[x]_{补} = 11.101001, [y]_{补} = 1.101011$

$[-x]_{补} = 00.010111$

$$
\begin{array}{rl}
00.000000| & 1.10101\underline{10} \\
+00.010111 & \gg 1 \\
00.001011 & 1|1.1010\underline{11} \\
\gg 1 & \\
00.000101 & 11|1.101\underline{01} \\
+11.101001 & \gg 1
\end{array}
$$

$11.110111 \quad 011|1.10\underline{10}$

$$
\begin{array}{rl}
+00.010111 & \gg 1 \\
00.000111 & 0011|1.1\underline{01} \\
+11.101001 & \gg 1 \\
11.111000 & 00011|1.\underline{10} \\
+00.010111 & \gg 1 \\
00.000111 & 100011|\underline{1.1}
\end{array}
$$

$x \cdot y = 0.000111100011$

3. $[x]_{原} = 0, 010011; [y]_{原} = 0, 100011$

a. 原码一位乘

符号位 $0 \oplus 0 = 0$

$$\begin{array}{ll}
0,000000| & 0,10001\underline{1} \\
0,001001 & 1|0,1000\underline{1} \\
0,001110 & 01|0,100\underline{0} \\
0,000111 & 001|0,10\underline{0} \\
0,000011 & 1001|0,1\underline{0} \\
0,000001 & 11001|0,\underline{1} \\
0,001010 & 011001|0
\end{array}$$

$x \cdot y = 0,001010011001$

b. 原码两位乘

$[-x]_{补} = 11,101101$

符号位 $0 \oplus 0 = 0$

$$\begin{array}{rlr}
 & & C_j \\
00,000000| & 00,1000\underline{11} & \underline{0} \\
+11,101101 & \gg 2 & \downarrow 1 \\
11,111011 & 01|00,10\underline{00} & \underline{1} \\
+00,010011 & \gg 2 & \downarrow 0 \\
00,000011 & 1001|00,\underline{10} & \underline{0} \\
+00,100110 & \gg 2 & \downarrow 0 \\
00,001010 & 011001|\underline{00} & \underline{0}
\end{array}$$

$x \cdot y = 0,001010011001$

c. 补码一位乘

$[x]_{补} = [x]_{原} = 00,010011$

$[y]_{补} = [y]_{原} = 00,100011$

$[-x]_{补} = 11,101101$

$$
\begin{array}{rl}
00,000000| & 0,10001\underline{10} \\
+11,101101 & \gg 1 \\
11,110110 & 1|0,1000\underline{11} \\
 & \gg 1 \\
11,111011 & 01|0,100\underline{01} \\
+00,010011 & \gg 1 \\
00,000111 & 001|0,10\underline{00} \\
 & \gg 1 \\
00,000011 & 1001|0,1\underline{00} \\
 & \gg 1 \\
00,000001 & 11001|0,\underline{10} \\
+11,101101 & \gg 1 \\
11,110111 & 011001|\underline{01} \\
+00,010011 & \\
00,001010 & 011001
\end{array}
$$

$x \cdot y = 0,001010011001$

4. $[x]_{原} = 0.11011, [y]_{原} = 0.11101, S = 1 \oplus 0 = 1$

   a. 原码一位乘

$$
\begin{array}{ll}
00.00000| & 0.1110\underline{1} \\
00.01101 & 1|0.111\underline{0} \\
00.00110 & 11|0.11\underline{1} \\
00.10000 & 111|0.1\underline{1} \\
00.10101 & 1111|0.\underline{1} \\
00.11000 & 01111|0
\end{array}
$$

   $[x \cdot y]_{原} = 1.1100001111$

   b. 原码两位乘

   $[-x]_{补} = 1.00101$

$$
\begin{array}{rlr}
000.00000| & 000.111\underline{01} & \underline{0} \\
+000.11011 & \gg 2 & \downarrow 0 \\
000.00110 & 11|000.1\underline{11} & \underline{0} \\
+111.00101 & \gg 2 & \downarrow 1 \\
111.11010 & 1111|00\underline{0.1} & \underline{1} \\
+001.10110 & \gg 1 & \downarrow 0 \\
000.11000 & 01111|00 & 0
\end{array}
$$

   $[x \cdot y]_{原} = 1.1100001111$

   c. 补码一位乘

   $[x]_{补} = 0.11011, [y]_{补} = 1.00011$ $[-x]_{补} = 1.00101$

$$
\begin{array}{rl}
00.00000| & 1.0001\underline{10} \\
+11.00101 & \gg 1 \\
11.10010 & 1|1.000\underline{11} \\
 & \gg 1 \\
11.11001 & 01|1.00\underline{01} \\
+00.11011 & \gg 1 \\
00.01010 & 001|1.0\underline{00} \\
 & \gg 1 \\
00.00101 & 0001|1.\underline{00} \\
 & \gg 1 \\
00.00010 & 10001|\underline{1.0} \\
+11.00101 & \\
11.00111 & 10001
\end{array}
$$

$[x \cdot y]_{补} = 1.0011110001$