12.

(1) $0 \sim 2^{16}-1$

(2) $-(1-2^{-15}) \sim (1-2^{-15})$

(3) $-1 \sim (1-2^{-15})$

(4) $-(2^{15}-1) \sim (2^{15}-1)$

(5) $-2^{15} \sim (2^{15}-1)$

17.

(1) $X = 1.1000100$, $Y = 0.0100110$, $-Y = 1.0100110$

$[X]_{补} = 1.0111100$

$[-Y]_{补} = 1.1011010$

$[X]_{补} + [-Y]_{补} = 1.0010110$

$X-Y = 1.1101010 = -53/64$ 无溢出

(2) $X = 1.1010100$ $Y = 1.1000011$

$[X]_{补} = 1.0101100$

$[Y]_{补} = 1.0111101$

$[Z]_{补} = [X]_{补} + [Y]_{补} = 0.1101001 > 0$

$Z = (1.0010111)$ 有溢出

(3) $= -151/128$

$X = 01100001$ $Y = -54 = -0110110$

$-Y = 00110110$

$[X]_{补} = X$ $[X]_{补} + [-Y]_{补} = 10010111$

$[-Y]_{补} = -Y$ $= 151$ 有溢出

(4) $X = 01110110$ $Y = 10100100$

$[X]_{补} = 01110110$ $[Y]_{补} = 11011100$

$[X]_{补} + [Y]_{补} = 01010010$ 未溢出

$X+Y = 00111010 = 82$

18.

(1) $[X]_{原} = X = 0.110111$

$[Y]_{原} = 1.101110$

$X^* = 0.110111$ $Y^* = 0.101110$ $X_0=0$, $Y_0=1$

$Z_0 = X_0 \oplus Y_0 = 0 \oplus 1 = 1$

$X^* \times Y^* = 0.100\ 111\ 100\ 010$

$[X \times Y]_{原} = 1.100\ 111\ 100\ 010$

$X \times Y = -0.100\ 111\ 100\ 010$

原码一位乘

部分积	乘数
0.000000	.101110 → +0
→1 0.000000	0.10111 → $+X^*$
+ 0.110111	
0.110111	
→1 0.011011	10.1011 → $+X^*$
+ 0.110111	
1.010010	
→1 0.101001	010.101 → $+X^*$
+ 0.110111	
1.100000	
→1 0.110000	0010.10 → +0
→1 0.011000	00010.1 → $+X^*$
+ 0.110111	
1.001111	
→ 0.100111	100010

结果是 0.100111 100010

补码一位乘

$[X]_{补} = X = 0.110111$　　$[2X]_{补} = 01.101110$

$[Y]_{补} = 1.010010$　　$[-2X]_{补} = 10.010010$

$[-X]_{补} = 1.001001$

部分积	乘数 Y_n	Y_{n+1}	
00.000 000	1.010010	0	→ +0
→| 00.000 000	01.010010	0	→ $+[-X]_{补}$
11.001001			
11.001001			
→| 11.100100	101.010010	1	→ $+[X]_{补}$
00.110111			
00.011011			
→| 00.001101	1101.01001	0	→ +0
→| 00.000110	11101.0010	0	→ $+[-X]_{补}$
11.001001			
11.001111			
→| 11.100111	111101.001	1	→ $+[X]_{补}$
00.110111			
00.011110			
→| 00.001111	011110.1001	0	→ $+[-X]_{补}$
11.001001			
11.011000	011110.01001	0	→ 溢0

$[X \times Y]_{补} = 1.011000\ 011\ 1100$

$X \times Y = -0.100111\ 1000100$

部分积	乘数 $[Y]_{补}$ $Y_{n-1}\ Y_n\ Y_{n+1}$
000.000 000	11.010010 0
+ 110.010 010	$+[-2X_{补}]$
110.010010	
→111.100100	1011.0100 1
+ 000.110111	$+[X]_{补}$
000.011011	
→000.000110	11101.0 1 0
+ 000.110111	$+[X]_{补}$
000.111101	
→000.001111	01111011.0
+ 111.001001	$+[-X]_{补}$
111.011000	0111 10000 0

$[X\cdot Y]_{补}=111.011000011111$

$X\cdot Y=-0.100111100010$

(2) $X=-0.010111$ $X_{原}=1.010111$

$Y=-0.010101$ $Y_{原}=1.010101$

$X^*=0.010111$ $Y^*=0.010101$

$[-X^*]_{补}=1.101001$ $X_0=1$ $Y_0=1$ $Z_0=X_0\oplus Y_0=0$

$[X_{补}]=1.101001$ $[Y_{补}]=1.101011$

原码一位乘

部分积	乘数
0.000000	.010101 ⟶ + X^*
+ 0.010111	
0.010111	
→1 0.001011	1.01010 ⟶ +0
→1 0.000101	11.0101 ⟶ + X^*
+ 0.010111	
0.011100	
→1 0.001110	011.010 ⟶ +0
→1 0.000111	0011.01 ⟶ + X^*
+ 0.010111	
0.011110	0011.01
→1 0.001111	00011.0 ⟶ +0
→1 0.000111	100011.

$X \times Y = 0.000111100011$

$[-X]_{补} = 0.010111$

$[2X]_{补} = 1.010010$

$[-2X]_{补} = 0.101110$

补码一位乘

部分积	乘数 $[Y]_{补}$ Y_n Y_{n+1}
00.000 000	1.101011 0
+ 00.010 111	+ $[-X]_{补}$
00.010 111	
→ 00.001011	11.10101 1 → + 0
→ 00.000101	111.1010 1 → $[X]_{补}$
+ 11.101001	
11.101110	
→ 11.110111	0111.101 0 → + $[-X]_{补}$
+ 00.010111	
00.001110	
→ 00.000111	00111.10 1 → + $[X]_{补}$
+ 11.101001	
11.110000	
→ 11.111000	000111.1 0 → + $[-X]_{补}$
+ 00.010111	
00.001111	
→ 00.000111	1000111.1 → +0 → 清0

$[X \times Y]_{补} = 00.000\ 111\ 100\ 011$

补码两位乘

部分积	乘数 $Y_{n-1}\ Y_n\ Y_{n+1}$
000.000 000	11.10110
+000.010 111	+[X]补
000.010 111	
→2 000.000101	11 11.10 1 0 1
+000.010111	+[-X]补
000.011100	
→2 000.000111	00 1 1 1 1.1 0 1
+000.010111	+[X]补
000.011110	
→2 000.000111	1 0 0 0 1 1 1 1 .1 +0
000.000111	1 0 0 0 1 1 0 0 0 ↘清0

$[X\times Y]_{补}=0.000\ 111\ 100\ 011$

19.

(1) $X_{原}=1.10101$ $Y_{原}=0.11011$

$X^*=0.10101$ $Y^*=0.11011$

$[-Y^*]_{补}=1.00101$ $Q_0=X_0\oplus Y_0=0\oplus 1=1$

$[X\div Y]_{原}=1.110\ 00$

$X^*\div Y^*=0.11000$

$R^*=0.000001\ 1000$

被除数/余数	商
0.10101	
+ 1.00101	
1.11010	
←1.10100	0.
+ 0.11011	+ Y^*
0.01111	
←0.11110	0.1
+ 1.00101	+ $[-Y^*]_{补}$
0.00011	
←0.00110	0.11
1.00101	+ $[Y^*]_{补}$
1.01011	
←0.10110	0.110
0.11011	+ Y^*
1.10001	
←1.00010	0.1100
0.11011	+ Y^*
1.11101	0.11000
0.11011	+ Y^*
0.11000	$R^* = 0.11000 \times 2^{-5}$
$X \div Y = 1.11000$	$R = -0.00000\ 11000$

(2) $X^* = 0.01101$

$X = 13/32 = 0.01101 \quad Y = -0.11011 = 1.11011$

$[X^*]_{补} = 0.01101 \quad [Y^*]_{补} = 0.11011 \quad [-Y^*]_{补} = 1.00101$

0.01101 + 1.00101	试减 $+[-Y^*]_{补}$
1.10010 ← 1.00100 + 0.11011	0. $+[Y^*]_{补}$
1.11111 ← 1.11110 + 0.11011	0.0 $+[Y^*]_{补}$
0.11001 ← 1.10010 + 1.00101	0.01 $+[-Y^*]_{补}$
0.10111 ← 1.01110 + 1.00101	0.011 $+[-Y^*]_{补}$
0.10011 ← 1.00110 + 1.00101	0.0111 $+[-Y^*]_{补}$
0.01011	0.01111 $+[-Y^*]_{补}$

$X \div Y = 1.01111$

$R = 0.01011 \times 2^{-5} = 0.0000001011$