

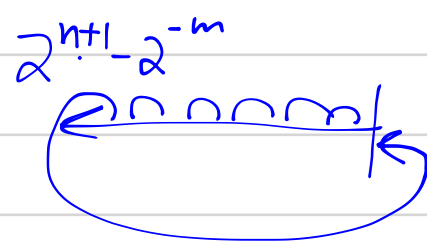
Addition & Subtraction with carry

Q 3.2

$$\begin{array}{r}
 11011101 \\
 + 111011 \\
 \hline
 [1] 1010100
 \end{array}$$

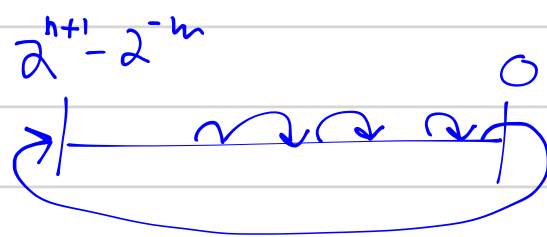
carry

$$\begin{array}{r}
 11.25 \\
 14.75 \\
 \hline
 (26.00) 10.00
 \end{array}$$



$$\begin{array}{r}
 \cancel{1}1\cancel{0}1\cancel{1}1\cancel{0}1 \\
 - 000111 \\
 \hline
 [1] 111101
 \end{array}$$

borrow



Signed numbers

$$y = (-1)^{a_{n+1}} \times \left(\sum_{i=-m}^n a_i b^i \right) \quad \text{--- sign & mantissa.}$$

$$\begin{aligned}
 -3 &= (-1)^1 \times (0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0) \\
 &= 10011 \quad (\text{sign + mantissa})
 \end{aligned}$$

$$y = \begin{cases} \sum_{i=-m}^n a_i b^i & : a_n = 0 \\ -1 \times \sum_{i=-m}^n \bar{a}_i b^i & : a_n = 1 \end{cases} \quad \text{--- ones complement}$$

$T=0$

$$\begin{aligned}
 -3 &= -1 \times (\bar{1} \times 2^4 + \bar{1} \times 2^3 + \bar{1} \times 2^2 + \bar{0} \times 2^1 + \bar{0} \times 2^0) \\
 &= 11100 \quad (\text{one's comp})
 \end{aligned}$$

$$y = -a_n b^n + \sum_{i=-m}^{n-1} a_i b^i \quad \text{--- two's complement}$$

$$\begin{aligned}
 -3 &= -1 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\
 &= 11101 \quad (\text{two's comp.})
 \end{aligned}$$

$$\lim_{x \rightarrow \infty} \frac{1}{x} = +0$$

$$\frac{1}{\lim_{x \rightarrow \infty} \frac{1}{x}} = \infty$$

$$\lim_{x \rightarrow -\infty} \frac{1}{x} = -0$$

$$\frac{1}{\lim_{x \rightarrow -\infty} \frac{1}{x}} = -\infty$$

Binary	unsigned.	one's	two's	sum
000	0	+0	0	+0
001	1	1	1	1
010	2	2	2	2
011	3	3	3	3
100	4	-3	-4	-0
101	5	-2	-3	-1
110	6	-1	-2	-2
111	7	-0	-1	-3
Range	7	6	7	6

Q signed.

Range is the length of the number line between the most negative value and the most positive value.

Addition + subtraction of signed #'s

$$\begin{array}{r} 110.11 \\ + 011.01 \\ \hline [1] 010.00 \end{array}$$

Q 2.2s

$$-4 + 2 + 0.5 + 0.25 = -1.25$$

Q 2.2s

$$2 + 1 + 0.25 = 3.25$$

Q 2.2s

2 ✓

carry, no overflow

$$\begin{array}{r} 1011 \\ + 001 \\ \hline 100 \end{array}$$

3

1

-4

overflow, no carry.

overflow \equiv sign bit changes incorrectly.

$$111.00 \text{ Q2.2s} + 10011.00 \text{ Q4.2s}$$

Always pad with MSB!

$$= 11111.00 + 10011.00 \text{ Q4.2s}$$

$$\begin{array}{r} 11111.00 \\ + 10011.00 \\ \hline [1] 10010.00 \end{array} \quad \begin{array}{l} -1 \\ -13 \\ -14 \end{array} ; \text{ carry, no overflow.}$$

$$\begin{array}{r} 11111.00 \\ - 10011.00 \\ \hline 01100.00 \end{array} \quad \begin{array}{l} -1 \\ -13 \\ +12 \end{array} \text{ no carry, no overflow.}$$

Decimal to signed binary

unsigned decimal \rightarrow unsigned binary \rightarrow signed binary.

-21

Choosing $n = 5$, $m = 2$

$$21_{10} = 010101.00$$

$$\begin{array}{r} 101010.11 \quad (\text{Ones complement}) \\ + \text{LSB} \\ \hline 101011.00 = -21 \end{array}$$

$$-34 = 1011110.00 \text{ Q6.2s}$$