Chapter 3

Binary Addition:

Four Basic Rules of Binary Addition:

0 + 0 = 0   sum = 0, carry = 0

0 + 1 = 1   sum = 1, carry = 0

1 + 0 = 0   sum = 1, carry = 0

1 + 1 = 10   sum = 0, carry = 1

1 + 1 + 1 = ?

$$\begin{array}{r} 1 \\ +1 \\ \hline 10 \\ +1 \\ \hline 11 \end{array}$$

carry   sum

Example 1: 110 + 100 = ?

$$\begin{array}{rl} {\scriptstyle 1\ 0\ 0\ \ } & \\ 110 & (6) \\ +100 & (4) \\ \hline 1010 & \end{array}$$

Example 2: 111 + 11 = ?

$$\begin{array}{rl} {\scriptstyle 1\ 1\ \ \ } & \\ 111 & (7) \\ 11 & (3) \\ \hline 1010 & (10) \end{array}$$

$$\begin{array}{r} 10 \ (2) \\ \cancel{0} \\ -1 \\ \hline 1 \end{array}$$

Binary Subtraction:

$0 - 0 = 0$

$1 - 0 = 1$

$1 - 1 = 0$

$0 - 1 =$

Example 1: 101 - 011 = ?

$10 = 2$

$$\begin{array}{cccc} & 0 & 10 & \\ & \cancel{1} & \cancel{0} & 1 \\ - & 0 & 1 & 1 \\ \hline & 0 & 1 & 0 \end{array}$$

Example 2: 110 - 101 = ?

$$\begin{array}{cccc} & & 0 & 10 \\ & 1 & \cancel{1} & \cancel{0} \\ - & 1 & 0 & 1 \\ \hline & 0 & 0 & 1 \end{array}$$

Binary Multiplication:

Four Basic Rules of Binary Multiplication:

0 x 0 = 0

0 x 1 = 0

1 x 0 = 0

1 x 1 = 1

Example 2: 111 X 101 = ?

$$
\begin{array}{cccccc}
 & & & 1 & 1 & 1 \\
 & & & 1 & 0 & 1 \\
\hline
 & & 1 & 1 & 1 & 1 \\
 & 1 & 0 & 0 & 0 & \\
+ & 1 & 1 & 1 & & \\
\hline
1 & 0 & 0 & 0 & 1 & 1
\end{array}
$$

Floating Point Numbers

Scientific notation: A notation that renders numbers with a single digit to the left of the decimal point.

Normalized Number: A number in scientific notation that has no leading 0s is called a normalized number.

0.001

$\boxed{1.0 \times 10^{-3}} \longrightarrow$ scientific Notation.

10.0×10^{-4}

0.1×10^{-2}

* sign
* Fraction / mantissa
* Exponent.

- Floating-point number (also known as a real number) consists of two parts plus a sign.
- The mantissa is the part of a floating-point number that represents the magnitude of the number and is between 0 and 1.
- The exponent is the part of a floating-point number that represents the number of places that the decimal point (or binary point) is to be moved.
- For binary floating-point numbers, the format is defined by ANSI/IEEE Standard 754-1985 in ~~three~~ two forms:
    - single-precision
    - double-precision

Example: Convert the decimal value 2.75 to IEEE-754 single precision format. Write your converted result in hexadecimal format.

bias = 127.

IEEE-754 single precision.

sign	Exponent	Fraction.
1	8	23

→ 32 bit

$$2.75_{10} = 10.11_2 = \underbrace{1.\underbrace{011}_{\text{Fraction.}} \times 2^{1}}_{\text{exponent.}}$$

Weight:	2	1		0.5	0.25
Binary:	1	0	.	1	1

sign = 0

Actual Exponent = Exponent + bias

= 127 + 1

= 128. $\underbrace{1000\ 0000}_{8\text{ bits}}$.

Fraction = $\underbrace{0\ 1100 \ldots 0}_{23\text{ bits}}$.

32-bit

0	1000 0000	0110 0000 0000 0000 0000 000

4 0 3 0 0 0 0 0

Example: Convert the decimal value -4.25 to IEEE-754 single precision format. Write your converted result in hexadecimal format.

Weight :	2^2 (4)	2^1	2^0	.	2^{-1}	2^{-2} (0.25)
Binary :	1	0	0	.	0	1

$-4.25 = -100.01 = -1.\underbrace{0001} \times 2^2$

sign = 1

Bias = 127   1 0 0 0 0 0 0 0

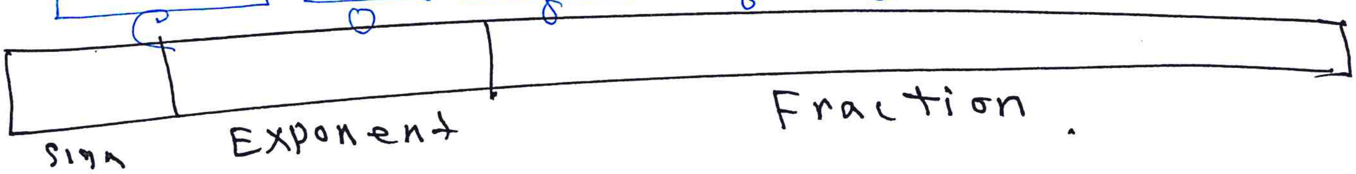
Exponent = 127 + 2 = ~~129~~.

1000 0001

Fraction = 0001

$$\underbrace{1 \; 100}_{C}\underbrace{0\;0001}_{0}\;\underbrace{0001}_{8}\;\underbrace{0000}_{8}\;\underbrace{0000}_{0}\;\underbrace{0000}_{0}\;\underbrace{0000}_{0}\;\underbrace{000}_{0}$$

1 1000 0001 0001 0000 0000 0000 0000 000



0XC0880000