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Computer Organization and Architecture

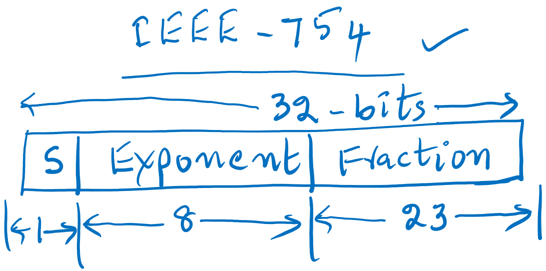
Data Representation part-2

ABOUT ME : MURALIKRISHNA BUKKASAMUDRAM

- M.Tech with 20 years of Experience in Teaching GATE and Engineering colleges
- IIT NPTEL Course topper in Theory of computation with 96 %
- IGIP Certified (Certification on International Engineering educator)
- GATE Qualified
- Trained more than 50 Thousand students across the country
- Area of Expertise : TOC,OS,COA,CN,DLD

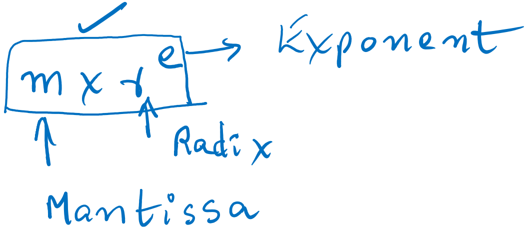
Data Representation part-2

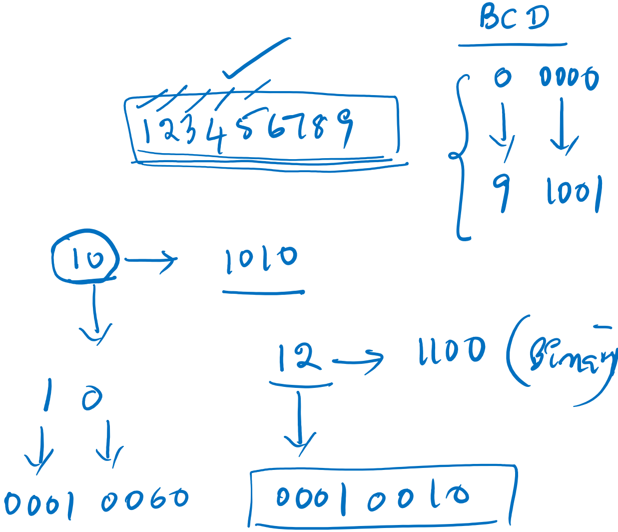
Floating point Representation



Very Small Numbers

Very Large Numbers.





$123456789 = 1.23456789 \times 10^8$ Normalized

0.123456789×10^9 Un-normalized

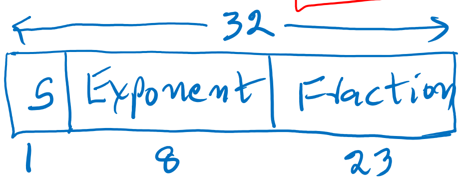
Data Representation part-2

IEEE-754 Single Precission floating point Representation

$$N = (-1)^{S} \times 1.\text{Fraction} \times 2^{\text{Exp}-127}$$

$$(1 \le \text{Exp} \le 254)$$

127 is a biased value.



Example 1 :-

$$\boxed{-6\frac{5}{8}} = -(110\cdot101)_2$$

$$8)\,50\,(0.625$$
$$48$$
$$20$$
$$16$$
$$40$$
$$40$$
$$\boxed{0}$$

$$0.625 \times 2$$
$$1.250 \times 2$$
$$0.500 \times 2$$
$$1.\boxed{000}$$

$$\frac{4}{8} = \frac{1}{2} \quad 2^{-1} \quad 2^{-3}$$

$$2\,|\,6$$
$$2\,|\,3 - 0$$
$$1 - 1$$

$$2^{2} + 2^{1} + \frac{1}{8} + \frac{4}{8}$$

$$\boxed{110.101}$$
$$2^{-1} \quad 2^{-2} \quad 2^{-3}$$

Data Representation part-2

$$\boxed{-6\frac{5}{8}} = -(110\cdot101)_2 = -(1\cdot10101)\times 2^{2}$$

$$= -1\cdot10101 \times 2^{\textcircled{2}}$$ ✓

1

01

001

0001

$\cdot 1$

$\cdot 100$

$\cdot 10$

$\frac{\cdot 1}{\cdot 01}$ x

$-6\frac{5}{8}$ ①

$+6\frac{5}{8}$ ⓪

$Exp - 127 = 2$

$Exp = \boxed{129}\ (10000001)$ ✓

$Sign = 1$

$Fraction = 10101\,000000\,000000000000$

12

$1\cdot2 \times 10^{1}$

$0\cdot12 \times 10^{2}$

$110\cdot101$

$1\cdot10101 \times 2^{2}$

S Exponent Fraction

1	1000	0001	1010	1000	0000	0000	0000	0000

C0D40000

0xC0D40000 ✓

Data Representation part-2

Example 2 :– $-(26.125)_{10} = (11010.001)_2$

$$\begin{array}{r|l} 2 & 26 \\ 2 & 13 - 0 \\ 2 & 6 - 1 \\ 2 & 3 - 0 \\ & 1 - 1 \end{array}$$

$16 + 8 + 2$

$2^4 \quad 2^3 \quad 2^1$

0.125×2

0.250×2

0.500×2

1.000

$= -(11010.001)_2$

$= -(1.1010001) \times 2^{\boxed{4}}$

Exp − 127 = 4

Exp = 131 (1000 0011)

Sign = 1

Fraction : 1010001000000000000000
00000

S Exponent Fraction

1 1 0 0 | 0 0 0 1 1 | 1 0 1 | 0 0 0 1 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 0 0 0 0 0

C 1 D 1 0000

0x C1D10000

Data Representation part-2

Example 3 :– what is the decimal value of the following Floating Point Number.

$N = (-1)^S \times 1.F \times 2^{Exp-127}$

1	10000111	01010000000000000000000

$Exp = 135$

$S = 1$

16
64
256
+ 336

$N = (-1)^1 \times 1.01010----0 \times 2^{135-127}$

$= -(1.01010000--0) \times 2^8$

$= -101010000.00---0$

$= -336.0$

Data Representation part-2

1. Given the following binary number in 32-bit (single precision) IEEE-754 format:

   00111110011011010000000000000000

   The decimal value closest to this floating-point number is

   A. 1.45×10^{1}

   B. 1.45×10^{-1}

   C. 2.27×10^{-1}

   D. 2.27×10^{1}

Data Representation part-2

2. Consider the following IEEE 32-bit floating point number:

   001111110 10100000000000000000000.

   What is the decimal value equivalent to given number ?

   A. 0.25

   B. 3.25

   C. 0.8125

   D. 0.9375

Data Representation part-2

3. The decimal value 0.5 in IEEE single precision floating point representation has

   A. fraction bits of 000…..000 and exponent value of 0

   B. fraction bits of 000……000 and exponent value of –1

   C. fraction bits of 100……000 and exponent value of 0

   D. no exact representation

Data Representation part-2

Double Precision

S	Exponent	Fraction.
1	11-bits	54 bits

→ what is the IEEE-754 single Precision representation of the decimal number −9.25

Solution :—

$$-9.25 = -(1001.01)_2 = -(1.00101) \times 2^{3}$$

$$\begin{array}{r} 0.25 \\ \times 2 \\ \hline 0.50 \\ \times 2 \\ \hline 1.00 \end{array}$$

$Exp - 127 = 3$, $Exp = \underline{130}$, $s = 1$

1100	0001	0001	0100	0000	0000	0000	0000
C	1	1	4	0	0	0	0

0x C1140000