

Computer Architecture

Tutorial 4 – Floating Point Numbers - Answers

1) Binary fractions are:

- a) 5.5 is **101.1**
- b) 8.25 is **1000.01**
- c) 9 is **1001**

0.3 \Rightarrow **0.6, 1.2, 0.4, 0.8, 1.6, 1.2** \rightarrow 01001 1001 1001 etc.

9.3 is **1001.01001 1001 1001** repeating etc.

- d) 11.46875 is **1011.01111**

2) Convert the binary number 1001.1010101 to decimal.

1001 binary is 9 decimal

.	1	0	1	0	1	0	1
128	64	32	16	8	4	2	1

Sum=85

Fraction = $85 / 128 = 0.6640625$

Number = **9.6640625**

- 3) a) $101.1 = 1.011 \times 2^2$
- b) $1000.01 = 1.00001 \times 2^3$
- c) $0.00010101 = 1.0101 \times 2^{-4}$

4) Convert -31.3 to IEEE Single Precision format.

First convert to a binary number -31.3 = -11111.01001 1001 1001

Next Normalise

$$1.11110 \ 1001 \ 1001 \ 1001 \ 1001 \ 1001 \times 2^4$$

Significand field is **1111 0100 1100 1100 1100 110** (23 bits with 1. omitted)

Exponent field is $4+127 = 131 = \mathbf{1000 \ 0011}$

Number is -ve therefore Sign field is **1**

Sign	Exponent	Significand
1	1000 0011	1111 0100 1100 1100 1100 110

- 5) Convert the IEEE Single Precision format hex value C154 0000 to decimal.

C154 0000 = 1100 0001 0101 0100 0000 0000 0000 0000

Sign	Exponent	Significand
1	1000 0010	1010 1000 0000 0000 0000 000

Exponent field = 1000 0010 = 130 \Rightarrow Exponent = 130 - 127 = 3

Significand field = 10101 Adding Hidden Bit \Rightarrow 1.10101

Therefore number is $1.10101 \times 2^3 = 1101.01 = \text{Decimal } 13.25$

Sign is 1 therefore number is **-13.25**

- 6) Carry out the operation 31.3 + 13.25 in IEEE single precision arithmetic

Number	Sign	Exponent	Significand
31.3	0	1000 0011	1111 0100 1100 1100 1100 110
13.25	0	1000 0010	1010 1000 0000 0000 0000 000

Significand of Larger Number = 1.1111 0100 1100 1100 1100 110

Significand of Smaller Number = 1.1010 1000 0000 0000 0000 000

Exponents differ by 1. Therefore shift binary point of Smaller Number 1 place.

Significand of Larger Number = 1.1111 0100 1100 1100 1100 1100

Significand of Smaller Number = 0.1101 0100 0000 0000 0000 000

Significand of Sum = 10.1100 1000 1100 1100 1100 1100

Sum = $10.1100 1000 1100 1100 1100 1100 \times 2^4$

Normalise $1.01100 1000 1100 1100 1100 1100 \times 2^5$

Sign	Exponent	Significand
0	1000 0100	0110 0100 0110 0110 0110 011

- 7)

Fraction	Binary	Decimal
1/4	0.01	0.25
3/8	0.011	0.375
23/16	1.0111	1.4375
45/16	10.1101	2.8125
11/8	1.011	1.375
45/8	101.101	5.625
49/16	11.0001	3.0625