CSCI 516 - Fundamental Concepts in Computing and Machine Organization
Homework Assignment 3

Due on 11/01/2022 (Tuesday), 11:55PM

Requirement

- You need to do your assignment independently.
- You need to submit ".pdf" file which contains your solutions to D2L

Questions

1. Describe with an example how addition, subtraction, multiplication, and division is done in CPU using the binary number system.

2. Convert each of the following decimal values to IEEE-754 single and IEEE-754 double precision representation. Write your converted result in hexadecimal format. Clearly show all the steps.

- 3.75
- -12.5

3. Convert each of the following IEEE-754 floating point representation to decimal values. Clearly show all the steps.

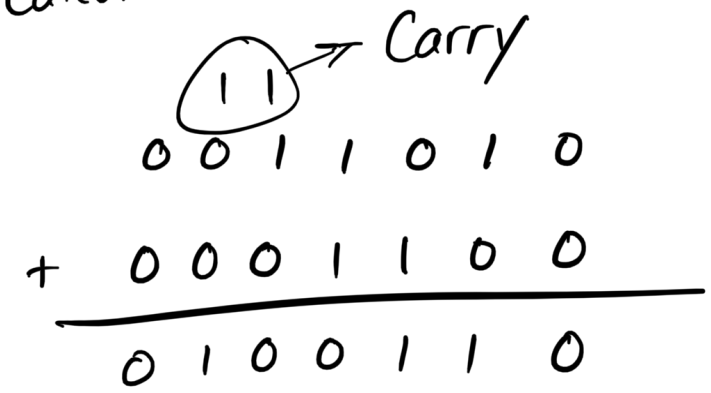
- 0x40200000
- 0xC1080000

1. Addition:

0011010 + 001100

= 00100110

Calculations:



Subtraction:

0011010 - 0001100

= 0001110

Calculations: (1 1 → Borrow)

```
  0 0 1 1 0 1 0
- 0 0 0 1 1 0 0
---------------
  0 0 0 1 1 1 0
```

Multiplication:

0011010 × 0001100

= 0100111000

Calculations:

```
    0 0 0 0 0 0 0
  0 0 0 0 0 0 0 ×
0 0 1 1 0 1 0 × ×
0 0 1 1 0 1 0 × × ×
-------------------
0 1 0 0 1 1 1 0 0 0
```

Division:

000110 ÷ 101010

= 111

Calculations:

```
          1 1 1
      ___________
000110 | 1 0 1 0 1 0
       - 1 1 0
       -------
         + 0 0 1
         - 1 1 0
         -------
           1 1 0
         - 1 1 0
         -------
             0
```

2.

3.75 to Hexadecimal

= 0x40700000

Calculations:

Since the number is positive, the sign bit is 0.

After normalizing the number

$3.75 = 1.111 \times 2^1$

Exponent = 1 + 127 (bias)

= 10000000

Mantissa =

11100000000000000000000

Therefore the binary number is

0100 0000 0111 0000 0000 0000 0000 0000

Which gives us a hexadecimal of

0x40700000

-12.5 to Hexadecimal

= 0xC1480000

Calculations:

Since the number is negative the sign bit is 1.

After normalizing the number

$-12.5 = 1.100000101001 \times 2^3$

Exponent = 3 + 127 (bias) = 10000010

Mantissa = 10010000000000000000000

Therefore the binary number is

11000001010010000000000000

Which gives us a hexadecimal of

0xC1480000

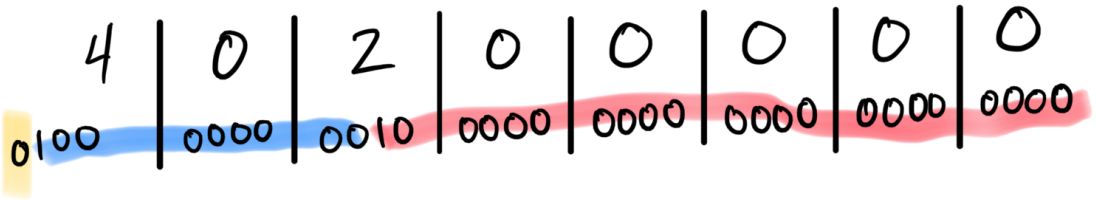
3.

0x40200000 to decimal

= 2.5

Calculations:

Convert hexadecimal to binary



IEEE 754 format is

Sign	Exponent	Mantissa
1 bit	8 bits	23 bits

Convert exponent to decimal

$\Rightarrow 10000000 = 128$

It is value implicit since $1 \leq \text{Exponent} \leq 254$

Implicit form is $(-1)^{s}(1.M) \times 2^{E-127}$

s = sign bit

0x C1080000 to decimal

= -8.5

Calculations:

Convert hexadecimal to binary

C	1	0	8	0	0	0	0
1100	0001	0000	1000	0000	0000	0000	0000

IEEE 754 format is

Sign	Exponent	Mantissa
1 bit	8 bits	23 bits

Convert exponent to decimal

$\Rightarrow 10000010 = 130$

It is value implicit since $1 \leq$ Exponent ≤ 254

Implicit form is $(-1)^{s}(1.M) \times 2^{E-127}$

s = sign bit

$(-1)^{1} \times (1.001) \times 2^{130-127}$

$-1 \times [1 + 0 \times (1/2) \times 0 + (1/2^{2}) \times 1 + 0 \times 1/2^{3} + 1 \times \frac{1}{2^{4}}] \times 2^{3}$

$-[1 + 1/16] \times 2^{3}$

$-\frac{17}{18} \times 8 = -8.5$