CENG204 - Computer Organization
Homework 1
Deadline: 21/03/2024 23:59 (Late Submissions are not allowed)

This homework is ***individual***. In this homework, you have a struct called ***FloatValue*** and you are going to simulate how floating numbers are stored in the memory. You are going to use ***32-bit IEEE float representation*** that we will mention about in Week 3. This float struct can be constructed with 2 options:

- struct FloatValue (a float number), or
- struct FloatValue (3 integer numbers) to represent sign bit, exp value and frac value of the float number as bits.

Investigate the constructors of the struct carefully. For example:

```
- FloatValue(float value) {
-     unsigned int intValue = *(unsigned int*)(&value);
-     /* this is going to change the type of float to unsigned int
-     Bits are not changing so you need to separate the bits
-     to represent sing, exp and frac part of the bits seperately.
-     // student code
- }
```

Penalty for cheating:

- If cheating is detected **once**, students will **loose half of their all homeworks grades** (Hw1, Hw2, Hw3, Hw4 and Hw5).
- If cheating is detected **twice**, students **will loose the grades of all homeworks**.
- If cheating is detected more than two times, students will get FF and failed from the course.
- Detection of cheating **will not be announced** until at the end of the semester.

What is **cheating**?

- Sharing code: by copying, retyping, looking at, or supplying a file
- Describing: verbal description of code from one person to another.
- Coaching: helping your friend to write a homework, line by line
- Searching the Web for solutions
- Copying code from a previous course or online solution
- You are only allowed to use code we supply

What is **NOT cheating**?

- Explaining how to use systems or tools
- Helping others with high-level design issues

You need to be careful about normalized and denormalized floating numbers. Analyze the code and IEEE float structure and try to understand first and then complete the missing parts (`//student code`) in the given *homework1.cpp* C++ source code file. Use GNU C Compiler (GCC).

Hint: You need to understand bitwise operations well to complete this homework.

In the main method, there are some test cases for you and you can use below test case results to validate your code:

```
struct FloatValue number(-1.0f / 0.0f);
```

```
Float Value: -inf
Float Value: -inf
sign=1, exp=255 (E=128), frac=0
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 1          (Is Special : 1)
Is NaN :  0              (Is Special : 1)
```

```
struct FloatValue number(1.0f / 0.0f);
```

```
Float Value: inf
Float Value: inf
sign=0, exp=255 (E=128), frac=0
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 1          (Is Special : 1)
Is NaN :  0              (Is Special : 1)
```

```
struct FloatValue number(numeric_limits<float>::quiet_NaN());
```

```
Float Value: nan
Float Value: nan
sign=0, exp=255 (E=128), frac=4194304
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 1)
Is NaN :  1              (Is Special : 1)
```

```
struct FloatValue number(0.0f / 0.0f);
struct FloatValue number(-0.0f / 0.0f);
```

```
Float Value: -nan
Float Value: -nan
sign=1, exp=255 (E=128), frac=4194304
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 1)
Is NaN :  1              (Is Special : 1)
```

```
struct FloatValue number(0.0f);
struct FloatValue number(0, 0, 0);
```

```
Float Value: 0.00000000000000000000000000000000000000000000000000
Float Value: 0.000000e+00
sign=0, exp=0 (E=-126), frac=0
Is Denormalized : 1      (Is Zero : 1)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(0, 0, 0b00000000000000000000001);
```

```
Float Value: 0.00000000000000000000000000000000000000000000140130
Float Value: 1.401298e-45
sign=0, exp=0 (E=-126), frac=1
Is Denormalized : 1      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(0, 0, 0b1);
```

```
Float Value: 0.00000000000000000000000000000000000000000000140130
Float Value: 1.401298e-45
sign=0, exp=0 (E=-126), frac=1
Is Denormalized : 1      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(0, 1, 0b0);
```

```
Float Value: 0.00000000000000000000000000000000000011754943508222
Float Value: 1.175494e-38
sign=0, exp=1 (E=-126), frac=0
```

```
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(0, 1, 0b00000000000000000000001);
```

```
Float Value: 0.00000000000000000000000000000000000011754944909 52
Float Value: 1.175494e-38
sign=0, exp=1 (E=-126), frac=1
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(0, 2, 0b00000000000000000000001);
```

```
Float Value: 0.00000000000000000000000000000000000023509889819 04
Float Value: 2.350989e-38
sign=0, exp=2 (E=-125), frac=1
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(15213.0);
struct FloatValue number(0, 13 + bias, 0b11011011011010000000000);
```

```
Float Value: 15213.000000000000000000000000000000000000000000000000000
Float Value: 1.521300e+04
sign=0, exp=140 (E=13), frac=7189504
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(-15213.0);
struct FloatValue number(1, 13 + bias, 0b11011011011010000000000);
```

```
Float Value: -15213.000000000000000000000000000000000000000000000000000
Float Value: -1.521300e+04
sign=1, exp=140 (E=13), frac=7189504
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(-15213.239258);
```

```
Float Value: -15213.239257812500000000000000000000000000000000000000000000
Float Value: -1.521324e+04
sign=1, exp=140 (E=13), frac=7189749
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(0.239258);
```

```
Float Value: 0.23925800621509552001953125000000000000000000000000000000
Float Value: 2.392580e-01
sign=0, exp=124 (E=-3), frac=7667725
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

```
struct FloatValue number(3.402823466e38);
```

```
Float Value: 340282346638528859811704183484516925440.000000000000000000000000000000000000
Float Value: 3.402823e+38
sign=0, exp=254 (E=127), frac=8388607
Is Denormalized : 0      (Is Zero : 0)
Is Infinity : 0          (Is Special : 0)
Is NaN :  0              (Is Special : 0)
```

Submit only `homework1.cpp` file.