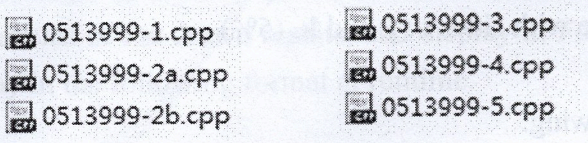
Programming (2019/4/16) Midterm Exam

Student id: _____________ **Name:** _____________

Read Me: Please follow the following naming rule in this exam otherwise you take the consequences.
In USB folder: StudentID-StudentName
In Answer folder: Please follow each naming rule defined by each question.

example:



0513999-1.cpp
0513999-2a.cpp
0513999-2b.cpp
0513999-3.cpp
0513999-4.cpp
0513999-5.cpp

1. Let n be a decimal integer and b_n be the corresponding binary representation of n.

(a) Write a C++ program that reads a decimal integer n and returns b_n, where $0 \leq n \leq 100000$. For example, if $n = 65$, then $b_n = \overset{64\,32\,16\,8\,4\,2\,1}{1000001}$. (5%)

(b) Write a C++ program that reads a decimal integer n and returns digit frequencies of b_n, where $0 \leq n \leq 100000$. For example, if $n = 65$, and digits frequencies of $b_n = 1000001$ for digits 0 and 1 are 5 and 2, respectively. (5%)

2. A fraction a/b is called **reduced** if a and b are relatively prime, that is *gcd*(a,b) = 1. For instance, 1/2 is a reduced fraction, while 4/6 is not a reduced fraction.

(a) Write a C++ program that reads 2 integers a, b, and returns the reduced fraction of fraction a/b, where 1 ≤ a, b ≤ 10000. For example, if integers 4 6 are entered, the output would be 2/3. (5%)

(b) Write a C++ program that reads 4 integers a, b, c, d, and returns the reduced fraction of multiplication of two fractions (a/b) and (c/d), where 1 ≤ a, b, c, d ≤ 10000. For example, if integers 2 3 4 6 are entered, the output would be 4/9 (because (2/3) × (4/6) = 4/9). (5%)

(c) Write a C++ program that reads 4 integers a, b, c, d, and returns the reduced fraction of addition of two fractions (a/b) and (c/d), where 1 ≤ a, b, c, d ≤ 10000. For example, if integers 2 3 4 6 are entered, the output would be 4/3 (because (2/3) + (4/6) = 4/3). (5%)

3. Let a, b and c be three positive numbers, where 1 ≤ a, b, c, d ≤ 10000. We say that a, b and c satisfy the triangle inequality condition if the sum of any two of them is larger than the other one. The values a, b and c present the side lengths of a triangle if they satisfy the triangle inequality condition. A triangle of side lengths a, b and c is an **acute triangle** if $a^2 + b^2 > c^2$ for $a < b < c$. A triangle of side lengths a, b and c is **an obtuse triangle** if $a^2 + b^2 < c^2$ for $a < b < c$. A triangle of side lengths a, b and c is a **right triangle** if $a^2 + b^2 = c^2$ for $a < b < c$. The area of a triangle of

side lengths a, b and c can be obtained by the following Heron's formula:

$TriArea(a, b, c) = (s(s-a)(s-b)(s-c))^{1/2}$, where $s = (a+b+c)/2$

(a) Write a C++ program that reads three positive numbers, and print the type of triangle if they could present the sides of a triangle. (5%)

(b) Write a C++ program that reads three positive numbers, and print the area of the triangle presented by them if they could present the sides of a triangle. Your program must use function **double TriArea(double i, double j, double k)** that returns the area of triangle with sides **i**, **j**, and **k.** (5%)

4. Please complete the following:

(a) (10%) Write a function that inputs three integer parameters which representing a 3D integer vector (x_1, x_2, x_3), and returns the inverse of its norm, i.e., $1/\sqrt{x_1^2 + x_2^2 + x_3^2}$. Call the function with arguments (1, 2, 1) in `main()`.

(b) (10%) Use `for` loops to print the following pattern:

```
******1
*****21
****321
***4321
**54321
*654321
7654321
```

(c) (15%) Prompt the user to input an integer containing only 0s and 1s (i.e., a "binary" integer), and then print its decimal equivalent, e.g., the decimal equivalent of binary 1101 is 1 * 1 + 0 * 2 + 1 * 4 + 1 * 8 or 13.

[Hint: Use the modulus and division operators to pick off the "binary" number's digits one at a time from right to left.]

5.

(10%) Write a function *lcm*(int, int) that returns the least common multiple (最小公倍數) of the two inputted positive integers.

[*Hint:* You may want to find the greatest common divider first, and then use it to compute the least common multiple.]

(5%) Write a main function that lets the user input an arbitrary pairs of integers and displays their least common multiple by using the return value of *lcm*.

6.

(a) (10%) Write a function *draw()* that implements a random integer X ranging from 1 to 4 according to a probability distribution such that `Pr[X=1]:Pr[X=2]:Pr[X=3]:Pr[X=4]=4:3:2:1`, and returns the realized number every time it is called. [*Hint:* You may want to use function *rand()* with seeding in writing this function.]

(b) (10%) Write a main function that calls *draw()* 1000 times, records the frequencies of the drawn results, and display it. For example, you might see a display in the following format at runtime.

```
1: 398
2: 301
3: 197
4: 104
```