請照題號次序作答
Please use C, C++, Java or Python programming language to design your computer programs.

1. (20%) Given the function of **Least Common Mutiple** of two positive integers *x, y* is *lcm*(*x, y*), and the function of **Greatest Common Divisor** of two integers *x, y* is *gcd*(*x, y*). And we have the following properties.

$lcm(a, b) \times gcd(a, b) = a \times b$
$gcd(a, a) = a$
$gcd(a, b) = gcd(a - b, b)$, if $a > b$
$gcd(a, b) = gcd(a, b - a)$, if $b > a$

Implement the functions of *gcd*(*x, y*) and *lcm*(*x, y*) with programing language, given x, y are two positive integers.

2. (20%) Given a function `double f(double x)`. Assume `f(x1) > 0` and `f(x2) < 0`, and `x1 < x2` are both `double` types, and there is only one root `x` of `f` function (`x1 < x < x2`). Write a program which can find the root `x` of function `f`, and remember that your value differs from the root `x` by less than `e`.

3. (20%)
   a. Given an array of numbers. Implement the **merge sort** algorithm to sort this array of numbers from the smallest number to largest number.
   b. What are the time complexities of merge sort in best case and worst case?

4. (15%) Give the positive number, please implement a function that can find the square root of a positive integer which has 50 significant figures(有效位數).

5. (15%) Terminology explanation or comparisons
   a. (5%) Describe **deadlock** and the necessary conditions to cause deadlock
   b. (5%) Describe the **bootstrap process** of Operating System
   c. (5%) Describe the differences between **pass-by-value** and **pass-by-reference**.

6. (10%) In mathematics, the **look-and-say sequence** is the sequence of integers beginning as follows: 1, 11, 21, 1211, 111221, 312211, 13112221, 1113213211, ...
   To generate a member of the sequence from the previous member, read off the digits of the previous member, counting the number of digits in groups of the same digit. For example:
   1 is read off as "one 1" or 11.
   11 is read off as "two 1s" or 21.
   21 is read off as "one 2, then one 1" or 1211.
   1211 is read off as "one 1, one 2, then two 1s" or 111221.
   111221 is read off as "three 1s, two 2s, then one 1" or 312211.
   ...
   Please write a program which can generate and output the first 20 numbers in this sequence.

試題隨卷繳回