2015 Winter Entrance Examination

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Programming

INSTRUCTIONS

1. Do not open this problem brochure until the signal to begin is given.
2. Write your examinee ID number below on this cover page.
3. An answer sheet and a draft sheet accompany this brochure. Write down your examinee ID number on these sheets.
4. You may choose any programming language to answer.
5. You may consult only one printed manual of a programming language during the examination. *You can use or copy any libraries or program fragments stored in your PC, but you may not connect to the Internet.*
6. By the end of the examination, make a directory/folder on your PC, whose name is the same as your examinee ID number, and put your program files and related files into the directory/folder. Copy the directory/folder onto the USB flash drive that you received.
7. At the end of the examination, the USB flash drive, the answer sheet and the draft sheet will be collected.
8. After these are collected, stay at your seat, until all the examinee program results have been checked briefly by the test supervisor.
9. After the brief check, try to save your program execution environment on the PC so that you can run your program as soon as possible during the oral examination in the afternoon.
10. *Leave your PC and this brochure together in the room* for the oral examination and stay out of the room until you are called.

Examinee ID _____

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Programming

(1) The following function f is a function often used as a simple random number generator.

$$f(n) = \begin{cases} 1 & \text{if } n < 1, \\ (161 \times f(n-1) + 2457) \mod 2^{24} & \text{otherwise.} \end{cases}$$

where n is a non-negative integer and *mod* denotes a modulus operator (the remainder). Write a program that computes $f(n)$ for given n. Then print the value of $f(100)$ by using this program.

(2) Write a program that counts the number of i such that $i < 100$ and $f(i)$ is an even number.

(3) Write a program that counts the number of i such that i is an odd number, $i < 100$, and $f(i)$ is an even number.

(4) Write a program that prints the value of $f(1000000)$.

(5) Write a program that computes the following function g where n is a non-negative integer:

$$g(n) = \begin{cases} 1 & \text{if } n < 1, \\ (1103515245 \times g(n-1) + 12345) \mod 2^{26} & \text{otherwise.} \end{cases}$$

Then run the program to print the values of $g(2)$ and $g(3)$.

(6) Write a program that computes the smallest positive integer k such that $g(n+k) = g(n)$ for any non-negative integer n.

(7) Write a program that computes the smallest positive integer k such that $h(n+k) = h(n)$ for any non-negative integer n. Write on the answer sheet why the program correctly computes k. h is a function defined as follows:

$$h(n) = g(n) \mod 2^{10}$$

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