OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

JANUARY 2018 EXAMINATION

CS210

Algorithms & Data Structures 1

Dr. S. Flynn, Prof. A. Winstanley, Dr. P. Maguire

Time allowed: 2 hours

Answer all *four* questions

All questions carry equal marks

1 Write a Java program given the following specification and provide comments which explain how your algorithm works.

Problem Statement
The task is to take in a credit card number, and find out if it is a valid credit card number or not. Credit card numbers follow an algorithm called Luhn's algorithm.

The formula verifies a number against its check digit, which is the last digit. This number must pass the following test:

1. From the rightmost digit, which is the check digit, and moving left, double the value of every second digit. If the result of this doubling operation is greater than 9 (e.g., 8 × 2 = 16), then add the digits together (e.g., 16: 1 + 6 = 7, 18: 1 + 8 = 9).
2. Take the sum of all the digits.
3. If the total modulo 10 is equal to 0 (if the total ends in zero) then the number is valid according to the Luhn formula; else it is not valid.

Assume an example of an account number "7992739871" that will have a check digit added, making it of the form 7992739871x. The sum of all the digits, processed as per steps 1 and 2, is 67+x. Thus x must be 3 to bring the total to be modulo 10 = 0. If x is not 3, then this is not a valid credit card number.

Input Format
An n-digit credit card number, where the last digit is the check digit.

Output Format
Output "VALID" if it is a valid credit card number and "INVALID" if it is not.

Constraints
$4<=n<=30$

Sample Input
4539682995824395

Sample Output
VALID

2   Write a Java program given the following specification and provide comments which explain how your algorithm works. Estimate the **Big O complexity** of your program and explain your reasoning clearly.

Problem Statement
The goal is to read in a number N and output the distance between the prime number that precedes it, and the prime that follows it. If the number itself happens to be prime, then output the distance to the subsequent prime. For example, if N is 7, then output 4, because the next prime is 11, which is 4 away.

Input Format
An integer N.

Output Format
The distance between the preceding and subsequent prime number at N.

Constraints
$2 \leq N \leq 1000$

Sample Input
10

Sample Output
4

[20 marks]

3   Write a Java method that takes in a Linked List object (double ended and doubly-linked, with each link containing an `int`) and deletes any Link whose `int` value is less than 100. The method then returns the Linked List object. Provide comments which explain how your algorithm works. Estimate the **Big O complexity** of your program and explain your reasoning clearly.

[20 marks]

4   a)   Identify the output that the following Java code produces and   [7 marks] explain your reasoning clearly.

```java
public class Recursion{

    public static void main(String[] args){
        System.out.println(mystery("Start"));
    }
```

```
        public static String mystery(String input){
            if(input.length()>10){
                return "Complete";
            }
            System.out.println("Running...");
            return (mystery(input+"x")+"OK");
        }
    }
```

b) Identify the output that the following Java code produces and   [7 marks]
    explain your reasoning clearly.

```
public class BitManipulation{

    public static void main(String[] args){
        System.out.println((((7&19)|23))<<2);
    }
}
```

c) Show how the following numbers would be sorted by mergesort.   [6 marks]
    State the **Big O complexity** of mergesort and explain why it is
    more efficient than bubble sort.

            84   25   83   96   36   10   57   29