Ollscoil Mhá Nuad
Maynooth University

SEMESTER 1
2022-2023

CS210
Algorithms & Data Structures 1

Dr. P. Healy, Dr. J. Timoney, Dr. P. Maguire

Time allowed: 2 hours

Answer all ***three*** questions

Your mark will be based on your ***three*** answers

All questions carry equal marks

Instructions

	Yes	No	N/A
Formulae and Tables book allowed *(i.e. available on request)*		X	
Formulae and Tables book required *(i.e. distributed prior to exam commencing)*		X	
Statistics Tables and Formulae allowed *(i.e. available on request)*		X	
Statistics Tables and Formulae required *(i.e. distributed prior to exam commencing)*		X	
Dictionary allowed *(supplied by the student)*		X	
Non-programmable calculator allowed	X		
Students required to write in and return the exam question paper		X	

[20 marks]

1 (a) Show how the values below would be sorted by the following algorithms, indicating clearly the swaps involved: [3 marks]

i) Bubble sort
ii) Selection sort
iii) Insertion sort

29 85 32 69 40 12

(b) What output is printed by the following program? Explain your reasoning. [3 marks]

```
public class BitManipulation{
   public static void main(String[] args){
        System.out.println((23|45)^((18&26)<<4));
   }
}
```

(c) What output is printed by the following program? Explain your reasoning. [3 marks]

```
public class Recursion{

   public static void main(String[] args){
        System.out.println(recursion(26));
   }

   public static int recursion(int x){
       if(x % 9 < 3){
           return 8;
       }else{
           return x % recursion(x - 2) + 1;
       }
   }
}
```

(d) Show where the values 170, 316 and 273 would be inserted into the following hash table using quadratic probing [3 marks]

0	
1	
2	596
3	
4	345
5	
6	
7	623
8	52
9	713
10	274

(e) Draw the directed graph represented by the adjacency matrix below. Show how i) a depth-first and ii) a breadth-first search would traverse the graph starting at A. [3 marks]

	A	B	C	D	E	F	G
A	0	1	0	0	0	0	0
B	1	0	1	1	0	0	0
C	0	1	0	0	0	0	0
D	0	1	0	0	1	1	0
E	0	0	0	1	0	0	0
F	0	0	0	1	0	0	1
G	0	0	0	0	0	1	0

(f) What is the Big O complexity of the Java method below? Explain your reasoning. [3 marks]

```
public void complexity(int n){
     int counter=0;
     for(int i = n; i>500; i--){
         for(int j=6; j<6*n; j=j+n){
             counter++;
         }
     }
}
```

(g) Show how the contents of a priority queue would adjust given the following commands, with highest values given highest priority. [2 marks]

insert 35
insert 19
insert 43
remove
insert 98
remove

remove
insert 69
remove

[20 marks]

2 Write a Java program which takes in an int *x* and prints out the distance from *x* to the nearest prime number. A prime number is a number which is divisible only by itself and 1 (e.g. 2, 3, 5, 7 etc.) If *x* is a prime, then the output should be 0.

Sample input
24

Sample output
1

[20 marks]

3 Write a Java program which uses a Monte Carlo simulation to compute the average number of rolls of a dice that are needed to see all 6 numbers come up (i.e. 1, 2, 3, 4, 5, 6).

[20 marks]

4 Write a Java program which takes in an int *n*, followed by a list of *n* English words. The program should sort the list of Strings according to how many unique characters they contain. If two Strings contain the same number of unique characters, then they should be sorted alphabetically. The program should print out the sorted list, with words containing the fewest number of unique characters coming first.

Sample input
tree
paper
car
banana

Sample output
banana
car
tree
paper