DUBLIN INSTITUTE OF TECHNOLOGY

DT211C BSc. (Honours) Degree in Computer Science (Infrastructure)

Year 1

SUMMER EXAMINATIONS 2017/2018

INTRODUCTION TO ALGORITHMS [CMPU1014]

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TUESDAY 15TH MAY 9.30 A.M. – 11.30 A.M.

2 HOURS

INSTRUCTIONS TO CANDIDATES

ANSWER **THREE** QUESTIONS OUT OF **FOUR**.

ALL QUESTIONS CARRY EQUAL MARKS.
EACH STUDENT WILL BE AWARDED A BONUS OF 1 MARK

Question 1

a) Define what is meant by binary tree and describe three applications of binary trees with examples. Write down three types of tree traversal.

(10 marks)

b) Describe in words how liner search works. Write down the pseudocode for this algorithm and specify the time complexity of your algorithm.

(10 marks)

c) Write a recursive function to calculate the N! for any positive integer

(13 marks)

Question 2

a) List clearly all the steps of the Merge Sort algorithm for sorting an array A of size n. Show how this algorithm sorts the following array in increasing order, by showing the sequence of values after *each* pass through the array:

E A S Y Q U E S T I O N

(12 marks)

b) Describe the Quick Sort Algorithm. Write down clearly, in English or pseudocode or draw a flowchart, the steps involved in this algorithm, and how it differs from the Merge Sort.

(10 marks)

c) Show how the binary search algorithm searches for 27 in the following list: 5 6 8 12 15 21 25 31.

(11 marks)

Question 3

a) Express a brute-force algorithm that finds the second largest element in a list $a_1, a_2, \ldots, a_n (n \geq 2)$ of distinct integers by finding the largest element, placing it at the beginning of the array, then finding the largest element of the remaining array, specify the time complexity of your solution.

(9 marks)

b) With the help of a stack, evaluate the following expressions given in postfix form, showing the stack contents after each operation:

```
(i)   2 8 ^ 5 10 * / 14 +
(ii) 12 6 - 7 2 - * 5 10 * / 20 -
(iii) 2 10 2 + * 12 / 1 +
```

(12 marks)

c) Give the order of growth (as a function of big O notation) of the running times of each of the following code fragments:

```
(i)   i:=1,
      j:=1
      while i ≤ n
            while j ≤ i
            print "hello" ;
            j := j + 1
        i := i + 1
(ii)  while n > 1
      print "hello" ;
      n := floor(n/2)
(iii)  t := 0
      for i = 1 to n
            for j = 1 to n
                  t := powf((i*t+j*t+1), 2)
```

(12 marks)

Question 4

a) Define what is meant by the terms:

(i) *Worst case,*

(ii) *Stack,*

(iii) Linked List,

(iv) *ADT.*

(12 marks)

b) Write down pseudocode, with the help of **diagrams**, to do the following operations on a linked-list, with ***head*** being the head-pointer to the list.

i) Print all nodes values in reversed order.

ii) Delete a node by value.

(10 marks)

c) Express a brute-force algorithm that finds the largest product of two numbers in a array a1, a2, . . . , an ($n \geq 2$) that is less than a threshold N.

(11 marks)