DUBLIN INSTITUTE OF TECHNOLOGY

BSc. (Honours) Degree in Computing

Year 1

SUMMER EXAMINATIONS 2015

INTRODUCTION TO ALGORITHMS
[CMPU1014]

DR MARTIN MC HUGH
DR. DEIRDRE LILLIS

DATE AND TIME,

FRIDAY 15TH MAY 4.00 – 6.00PM

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 the term algorithm, and explain why algorithms are important in computing? Write down 4 properties that any algorithm should have. Explain what is meant by the term *complexity* of an algorithm? Two algorithms to solve a problem have complexities of (i) ½ n^2 and (ii) 20n. For what values of n does algorithm (i) need less operations?

(10 marks)

b) Explain how the sequential search algorithm works, when searching an array A for a **key** element. Write down the pseudocode for this algorithm.

```
int sequential_search(A, n, key)
```

(10 marks)

c) Given an array A with N elements: A[0], A[1],…,A[N-1], draw a flowchart to read N, a **key** and the N elements into the array, and then search the array for key using the sequential search, and print out a suitable message at the end.

(13 marks)

Question 2

a) List clearly all the steps of the Bubble 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:

7 5 3 6 4 2

(12 marks)

b) The Selection Sort algorithm is a simple algorithm to sort an array. Write down clearly, in English or pseudocode, the steps involved in this algorithm, and how it differs from the Bubble Sort.

(10 marks)

c) In terms of the array size n, what is the complexity of each of the algorithms in (a) and (b) above using big-O notation? If the Bubble Sort method takes 1 second to sort a random array with 100 elements, approximately how long will it take if the array has 200, 300, 400 elements respectively? Show clearly how you compute your answers.

(11 marks)

Question 3

a) Write down the definition of a *queue* data structure. Describe clearly using **pseudocode** the two algorithms for *enqueing* and *dequeing* elements on a queue that is implemented using a linear array of size qmax.

(11 marks)

b) Explain what is meant by a stack data structure. With the help of a stack, evaluate the following expressions given in postfix form, showing the stack contents after each operation:

(i) 3 2 4 * + 9 +
(ii) 2 4 + 7 1 – *

(10 marks)

c) Write down the pseudocode for the `push(stack, item)` and `pop(stack)` functions for a stack implemented using an array with `size` elements.

(12 marks)

Question 4

a) Define what is meant by the terms
(i) *singly-linked list*,
(ii) *a doubly-linked list*,
(iii) *node*,
(iv) *pointer*.

Give 1 advantage of using a linked-list, and 1 advantage of using an array to implement an algorithm for a given problem.

(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) Add a node at the *head* of the list.
ii) Check if a linked-list with pointer *head* is empty.

(10 marks)

c) Write down pseudocode, with the help of a diagram, to print all the data (integers) stored in a linked-list. You are given the head of the list, *head*. The algorithm should be of the form `printlist(head)`. Explain briefly *each* line of pseudocode.

(11 marks)