DUBLIN INSTITUTE OF TECHNOLOGY
KEVIN STREET DUBLIN 8

BSc. (Honours) Degree in Computer Science

Year 1

SEMESTER 2 EXAMINATIONS 2013

ALGORITHM DESIGN & PROBLEM SOLVING

A. Curley
Dr. D. Lillis

Duration: 2 hours

Friday –17–May
4.00 – 6.00

Answer question (1) and *any two* of questions (2), (3), (4)

Question (1) is worth **40** marks.
Questions (2), (3), (4) are worth **30** marks each

1. (a) (i) Write an algorithm, in pseudo code, to determine the validity of a triangle (Hint: All three angles should add to 180 degrees).

(6 marks)

(ii) What is the complexity of the algorithm, that you provided in 1(a)(i)? Explain your answer.

(4 marks)

(b) (i) Describe briefly how the *insertion sort* algorithm works.

(6 marks)

(ii) Illustrate how the insertion sort algorithm works on the list: [7, 2, 4, 6, 8, 9, 6, 3]

(6 marks)

(c) Write a Haskell function findMin that calculates the minimum of a list of integers. Then show how findMin [3, 4, 1, 5, 2] would be evaluated.

(6 marks)

(d) **(i)** Write a recursive algorithm (in pseudo code), which computes the *greatest common divisor (GCD)* of two numbers.

(4 marks)

(ii) Illustrate the **call stack** that is used when the algorithm, that you provided in 1(d)(i) is implemented using the numbers (93, 15).

(4 marks)

(e) Determine the Big O complexity of $6 + 2x + 4x^2$

(4 marks)

2. **(a)** Write a recursive algorithm (in pseudo code), which provides a solution to the *Tower of Hanoi* problem.

(10 marks)

(b) What is the complexity of the algorithm in 2(a)? Explain your answer.

(4 marks)

(c) If the Tower Of Hanoi algorithm is implemented with 3 disks:

    i.   What is the *base case* of the algorithm?

(4 marks)

    ii. How many Tower of Hanoi **function calls** will be made?

(3 marks)

    iii. Illustrate how these function calls are added to/removed from a call stack.

(9 marks)

3. *A farmer wants to cross a river and take with him a wolf, a goat, and a cabbage. There is a boat that can fit himself plus either the wolf, the goat, or the cabbage. If the wolf and the goat are alone on one shore, the wolf will eat the goat. If the goat and the cabbage are alone on the shore, the goat will eat the cabbage.*

The farmer needs to bring the wolf, the goat, and the cabbage across the river.

(a) Draw a *state space graph* to find a solution for this problem.

(8 marks)

(b) Show how the state-space is traversed using:
    i. Depth first search

(5 marks)

    ii. Breadth first search

(5 marks)

(c) Which search (depth-first or breadth-first) reaches the goal state first?

(3 marks)

(d) Draw a flow chart for the *depth first search* algorithm.

(9 marks)

4. (a) What is the complexity of the *merge sort* algorithm. Outline exactly how you arrived at this answer.

(6 marks)

(b) Suppose you are given two sorted lists, for example [1,1,3,4] and [2,5,6,9]. Explain how these would be merged to form a single sorted list using the merge sort algorithm.

(6 marks)

(c)

Draw a flowchart for the process described in 4(b).

(8 marks)

(d)

Write an algorithm, in pseudo code, for the *binary search* algorithm.

(10 marks)