

*Programme Code: TU856, TU858*  
*Module Code: CMPU1001*

**TECHNOLOGICAL UNIVERSITY DUBLIN**  
Grangegorman

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TU856 – BSc. (Honours) in Computer Science  
TU858 – BSc. (Honours) in Computer Science  
(International)

*Year 1*

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*SEMESTER 2 EXAMINATIONS 2022/23*

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***CMPU1001 - Algorithm Design and Problem Solving***

**Internal Examiner(s):**

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Dr. Paul Doyle

**Instructions To Candidates:**

*Answer QUESTION 1 and ANY TWO questions of the remaining three available.  
Question 1 carries 40 marks while all further questions each carry 30 marks*

**Exam Duration:**

***TWO HOURS***

1. (a) The following algorithm has a number of errors in it.

```
AlgoX(disk, source, dest, spare)
  If disk = 0
    Move disk from spare to Dest
  else
    AlgoX (disk-1, source, spare, dest)
    move disk from spare to source
    AlgoX (disk-1, source, spare, dest)
```

- i. What is the name of this algorithm? (3 marks)
- ii. What is the goal of this algorithm? (3 marks)
- iii. Outline the errors in the algorithm. (4 marks)
- iv. Use a stack trace to show the correct execution of the algorithm where `disk = 2` (8 marks)

(b) i. Explain the following, outlining the main points defining each term :-

- a. Recursion
- b. Algorithm
- c. Order of Complexity

Give examples and diagrams as required.

- (9 marks)
- ii. Write a recursive algorithm to sum a list of numbers. (4 marks)
  - iii. What is the complexity of this algorithm in Big-O? Explain your answer. (4 marks)
  - iv. Show how your algorithm works by writing out the stack trace as it adds up the following list

0,1,2,3

(5 marks)

**2. (a)** The selection sort is a simple sorting algorithm. Explain how it works as follows:-

i. Write out pseudocode for the selection sort. (6 marks)

ii. Discuss the efficiency of the selection sort with reference to the best, average and worst case of its performance. (4 marks)

iii. Show the sort trace for the selection sort using the following data:-

0, 9, 8, 4, 3, 2, 2 (4 marks)

iv. Suggest one improvement to the basic algorithm. (2 marks)

**(b)** Define the term “divide and conquer”.

The Merge sort is more efficient than the selection sort – describe in Structured English how the merge sort works and explain its efficiency (4 marks)

Write pseudocode for the merge part of the Merge sort. Demonstrate how the algorithm works using the following data :-

0, 1, 4, 4, 2, 3, 5, 6 (10 marks)

**3. (a)** i. Write a Haskell program to calculate a term of the Fibonacci Sequence. (4 marks)

ii. If it took 1 second to calculate a single term, how long would it take to calculate the 40<sup>th</sup> term? Explain your reasoning. (4 marks)

iii. Looking at how this algorithm works, suggest a more efficient method to find a term of the Fibonacci sequence. Use imperative pseudocode to document your answer and explain how it improves on the original algorithm above. (10 marks)

iv. What is the big-O of your revised algorithm. (3 marks)

(b) What is the Big-O of these code fragments :-

```
i)  For (i=0;i<N;i++)  
      For (j=N;j>0;j--)  
          For (k=0;k<N;k++)  
              sum++
```

```
ii) For (i=0;i<N;i++)  
      For (j=N;j>0;j/=10)  
          sum++
```

```
iii) For (i=0;i<N;i++)  
      For (j=N;j>0;j--)  
          For (k=0;k<10;k++)  
              sum++
```

(9 marks)

4. (a) i. Draw a binary search tree for the following data :-

3, 9, 2, 1, 8, 6, 0, 1

(4 marks)

ii. Write out the following traversals of this tree :-  
a. Inorder  
b. Preorder  
c. Postorder

(6 marks)

(b) Describe the eight puzzle.

(5 marks)

Choosing a suitable way to represent the data, demonstrate the first 6 states of the puzzle.

(5 marks)

(c) The Breadth First Search is a strategy for locating a node in a tree. Write out an iterative algorithm to implement BFS in pseudocode.

(10 marks)