

Programme Codes: TU856, TU858
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TECHNOLOGICAL UNIVERSITY DUBLIN
CITY CAMPUS

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

Year 1

SEMESTER 2 EXAMINATIONS 2021/22

Algorithm Design and Problem Solving

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Instructions

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

1.

NOTE: This question is compulsory

(a) You have been asked to sort the following data :-

5, 7, 6, 8, 9, 10, 12, 11

Which of the elementary sorting algorithms should you select for this? Explain your reasoning with reference to Big O.

(6 marks)

(b) Write Pseudocode for the sorting algorithm you have chosen and trace how it would sort the data after each pass.

(14 marks)

(c) Write a recursive algorithm to calculate the greatest common divisor of 3 numbers.

Demonstrate how your algorithm works using a stack trace - the sequence of function calls and arguments. Use the following numbers as arguments to your function :-

(20, 10, 5)

(10 marks)

(d) Write a Haskell function which calculates the Fibonacci series of an integer. What is the order of growth of this function?

(10 marks)

2. (a) A farmer has to travel to the market crossing a river using a small rowing boat. He's taking his pet dog, a chicken, a tarantula spider, a silkworm caterpillar and some loose mulberry leaves. The very small boat could at most take the farmer and 2 other items at the same time.

The farmer observed the following :-

1. The dog would eat the chicken if they are left unattended.
2. The chicken would eat the spider if left unattended
3. The spider would eat the caterpillar if left unattended
4. The caterpillar would eat the leaves if unattended

How can he take everything across? Draw a state space graph to find a solution to the problem.

(10 marks)

(b) Explain in structured english how would you perform a breadth-first search of the tree? Code the algorithm using pseudocode.

(10 marks)

- (c) Use pseudocode to show how you could iteratively use a stack to traverse the tree.
What is this method of traversal called?

(10 marks)

3. (a) Use pseudocode to write a brute-force algorithm to find the distance between the two closest elements in an array of numbers.

What is the time efficiency of the algorithm expressed in Big-O?

(8 marks)

- (b) Give the time complexity of the following code fragments in Big-O :-

```
i) for (i=N; i>0; i--)  
    for (j=1; j<=N; j++)  
        count++;  
  
ii) for (i=N; i>0; i=i-5)  
    for (j=1; j<=1; j++)  
        for (k=1; k<=N; k++)  
            count++;  
  
iii) for (i=1; i<=N; i=i*21)  
    for(j=N; j>0; j--)  
        count++;
```

(6 marks)

- (c) Can you find a way to improve the performance of the problem in (a). Use pseudocode to show the algorithm.

What is the big-O of the new approach - explain your answer.

(16 marks)

4. (a) Using examples, explain the meaning of the term divide and conquer in terms of algorithm design.

(3 marks)

- (b) Write the merge sort algorithm in pseudocode. Use a stack trace showing function name and arguments to show how the following data would be sorted :-

7, 9, 4, 3

Number the lines of your algorithm and include these numbers when identifying the function calls in your stack trace.

(8 marks)

- (c) Write the algorithm for the merge part of the mergesort. Show how it would sort the numbers in the following array

{ 21, 22, 34, 45, 3, 7, 9, 11 }

(9 marks)

- (d) Describe how you could improve the performance of the merge sort, especially for arrays with a smaller number of elements. Explain your improvement with reference to Big-O.

(10 marks)