



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

DESIGN AND ANALYSIS OF ALGORITHMS

SCS 2212

MARCH 2025

This examination paper consists of 4 pages

Time Allowed: 3 hours
Total Marks: 100
Examiner's Name: Miss Nolwazi Ncube
External Examiner: Dr Cross Gombiro

INSTRUCTIONS

1. Answer any four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25
TOTAL	100

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QUESTION ONE

- a) Why is it important to analyse the efficiency of algorithms? [5]
- b) Arrange the following functions in increasing order of their asymptotic growth rates:
n, log n, n^2 , 2^n , $n \log n$, 1, n^3 , \sqrt{n} . [5]
- c) Prove or disprove: If $f(n) = O(g(n))$ and $g(n) = O(h(n))$, then $f(n) = O(h(n))$. [15]

QUESTION TWO

- a) Determine the Big O time complexity of the following code snippet: [5]
- ```
for i in range(n):
 j = 1
 while j < n:
 j *= 2
```
- b) Explain the difference between best-case, average-case, and worst-case time complexity. [5]
- c) Which of these is typically the most important to consider? Why? [5]
- c) Explain the key differences between divide-and-conquer and dynamic programming. When would you choose one over the other? [10]

### QUESTION THREE

- a) Describe how recurrence relations are important in the analysis of algorithms. [5]
- b) Explain how quick-sort works. Walk through the steps of sorting the following array using quick sort (using the first element as the pivot): [5, 1, 9, 2, 7, 3, 6]. [10]
- c) Explain how binary search works. What is the key requirement for using binary search?[10]

#### QUESTION FOUR

- a) Explain the key differences between Breadth-First Search (BFS) and Depth-First Search (DFS). [5]
- b) Discuss the importance of identifying overlapping subproblems in a dynamic programming problem. [5]
- c) How does dynamic programming exploit this property to improve efficiency? [5]
- d) Construct a minimum spanning tree using Kruskal's algorithm with your example. [10]

#### QUESTION FIVE

- a) Explain the relationship between NP-complete and NP-hard classes. [5]
- b) Write a Python program for adding  $n$  natural numbers and find the space required by that program. [10]
- c) Explain the non-deterministic sorting algorithm and also analyse its complexity. [10]

**END QUESTION PAPER**

