



# **MURANG'A UNIVERSITY OF TECHNOLOGY**

## **SCHOOL OF COMPUTING AND INFORMATION TECHNOLOGY**

### **DEPARTMENT OF INFORMATION TECHNOLOGY**

**UNIVERSITY POSTGRADUATE EXAMINATION**

**2024/2025 ACADEMIC YEAR**

**FIRST YEAR FIRST SEMESTER EXAMINATION FOR MASTER  
OF SCIENCE IN INFORMATION TECHNOLOGY**

**SIT 800 – PROBLEM SOLVING WITH PROGRAMMING**

**DURATION: 3 HOURS**

#### **INSTRUCTIONS TO CANDIDATES:**

1. Answer any FOUR questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

### QUESTION ONE (25 MARKS)

- a. Define the class P. how does it differ from NP. (4 marks)
- b. Explain the difference between private protected and public protected access modifiers in Java. How do they affect access to class members? (6 marks)
- c. Use the steps of problem solving to draw an analogy with those of solving programming problems accompanied by some explanation. (5 marks)
- d. Compare the performance of three sorting algorithms; merge sort, quick sort and insertion sort. Explain which algorithm performs the best and why. (10 marks)

### QUESTION TWO (25 MARKS)

- a. Discuss at least two real world application of SAT solves that work with CNF formulas. (6 marks)
- b. Using an example, illustrate polynomial time non-deterministic algorithm. (6 marks)
- c. In the problem of finding the shortest path in a weighted graph an NP compete problem? Justify your answer. (7 marks)
- d. Write a merge sort algorithm. Find out the best worst and average cases of this algorithm. Sort the following numbers using merge sort. (6 marks)

### QUESTION THREE (25 MARKS)

- a. What is a polynomial time verification algorithm? Provide an example of a problem that can be solved in polynomial time. (5 marks)
- b. Compare and array and linked list implementation of basic data structure such as stack and a queues (12 marks)
- c. Write a dynamic programming solution to solve the 0/1 knapsack problem. You are given a list of items, each with a weight and value, and a knapsack problem with a maximum capacity. Your solution should maximise the total value that can be carried without exceeding the capacity. (8 marks)

#### QUESTION FOUR (25 MARKS)

- a. Given a decision problem in NP, describe how you would prove that it is NP complete. What steps would you take? (10 marks)
- b. Implement a binary Tree (BsT) class with methods for insertion, deletion, searching and in-order traversal.
  - i. Insert the following integers into the BsT; 20,10,30,5,15,25,35. (5 marks)
  - ii. Delete the node with value 10 and perform an in-order traversal to show the results. (5 marks)
  - iii. Search for the value 25 in the tree and display the results. (5 marks)

#### QUESTION FIVE (25 MARKS)

- a. Describe an algorithm that runs in exponential time and explain why it is consider inefficient for large inputs. (4 marks)
- b. What are some common polynomial time complexities e.g.  $O(n)$   $O(n^2)$ ? Provide examples of algorithms that exhibit these complexities. (6 marks)
- c. Explain the role of approximation algorithms for problem that are solvable in exponential time. (6 marks)
- d. Provide an example of a graph that contain a Hamiltonian cycle and one that does not. Explain your reasoning. (9 marks)