



## **UNIVERSITY EXAMINATIONS**

**FIRST SEMESTER 2025/2026 ACADEMIC YEAR**

**THIRD YEAR EXAMINATION FOR THE DEGREE OF  
BACHELOR OF SCIENCE IN COMPUTER SCIENCE**

**COMP 313: DESIGN AND ANALYSIS OF ALGORITHMS**

***STREAM: R***

***TIME: 2 HRS***

***DAY: WEDNESDAY [14.30 – 16.30 P.M]***

***DATE: 04/02/2026***

**THIS QUESTION PAPER CONSISTS OF THREE (3) PAGES**

**PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.**

**SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION****QUESTION ONE (30 MARKS)**

- a) Briefly describe the following concepts as used with data structures and algorithms
- i. Algorithm complexity (2 Marks)
  - ii. Data abstraction (2 Marks)
  - iii. Data structure (2 Marks)
  - iv. Weighted graph (2 Marks)
- b) Distinguish between a queue and a stack. (4 Marks)
- c) Describe briefly (4 Marks)
- i. Any one sorting algorithm and
  - ii. Any one searching algorithm
- d) Given two scenarios: the first in which a problem solution involves a dynamic list (i.e. list in which there are a lot of deletions and insertions) and the second in which a problem involves many accesses to the interior values of a list. State with reasons which data structure will be suitable for each of the two scenarios? (4 Marks)
- e) Describe any two methods for storing binary trees in the computer. (4 Marks)
- f) Discuss three methods for storing binary trees in the computer. (6 Marks)

**QUESTION TWO (20 MARKS)**

- a) State the transpose symmetry property of  $O$  and  $\Omega$ . (4 Marks)
- b) Explain the properties of an algorithm with an example (5 Marks)
- c) Differentiate between Bigoh and omega notation with example. (5 Marks)
- d) What is meant by Divide – and – Conquer approach? (6 Marks)

**QUESTION THREE (20 MARKS)**

- a) Lists may be implemented statically as array-based lists or dynamically as linked lists. Explain the two differences between these two implementations. (4 Marks)
- b) Define tree traversal and describe the two main techniques used in traversing tree. (6 Marks)
- c) Explain how Matrix – chain Multiplication problem can be solved using dynamic programming with suitable a example. (5 Marks)
- d) Compare time complexity with space complexity. (5 Marks)

**QUESTION FOUR (20 MARKS)**

- a) The Huffman tree is a special type of binary tree. Describe the area of application for Huffman tree and use an appropriate example to illustrate the application. **(6 Marks)**
- b) Asymptotic notation is used to express algorithm complexity, with the Oh notation as the most popular of the three notations.
- Describe the other two notations **(4 Marks)**
  - Explain why the big-Oh notation is the most commonly used **(2 Marks)**
- c) Distinguish between a graph and a tree. **(2 Marks)**
- d) Describe **two** principal methods for representing graphs for computer algorithms. **(6 Marks)**

**QUESTION FIVE (20 MARKS)**

- a) Suppose that the matrix  $A_i$  has dimensions  $p_{i-1} \times p_i$ . Suppose that the optimal way to obtain the product  $A_i A_{i+1} \cdots A_j$  is by  $(A_i A_{i+1} \cdots A_k)(A_{k+1} \cdots A_j)$ . Let  $m[i, j]$  denotes the number of scalar multiplications to form the product  $A_i A_{i+1} \cdots A_j$ .

Derive a formula that obtains  $m[i, j]$  from  $m[i, k]$  and  $m[k + 1, j]$  assuming the optimal splitting is at  $k$ . **(7 Marks)**

- b) In the analysis of Randomized-Quicksort, we denoted by  $z_i$  the  $i$ th smallest element of the input array. Let  $Z_{ij} = \{z_i, z_{i+1}, \dots, z_j\}$ . We were interested in the event “the elements  $z_i$  and  $z_j$  are compared by the algorithm”. The first pivot element selected from the set  $Z_{ij}$  determines this event. Discuss **(8 Marks)**
- c) Explain the general principle of the Greedy method and also list the applications of the Greedy method. **(5 Marks)**