THE OPEN UNIVERSITY OF SRI LANKA

DEPARTMENT OF COMPUTER SCIENCE

B. SC. IT DEGREE PROGRAMME-2024/2025

Final Examination - 2024/2025

COU3306: Data Structures & Algorithms

Date: 16.11.2025 **Time: 9.30 am – 11.30 am**

There are six (06) questions on the paper and answer **FOUR (04)** questions **ONLY.**

Question 01

01. Distinguish between the following concepts.
    a. Reduction and Greedy method
    b. Space Complexity and Time Complexity
    c. Best Case and Average Case

02. Write the time complexity of the following function using the Big-O notation.
    $T(n) = 10 \log(n) + 5 (\log(n))^3 + 7n + 3n^2 + 6n^3$

03. Answer the following questions.
    a. Describe the advantages of LinkedList over Arrays.

    b. Give the similarity and differences between the following pairs of operations on a simple linked list (head only implementation).
        i. Insert front and Insert end

    c. Discuss how the extended linked list(head and tail implementation) can simplify the above mentioned operations in question b.

04. Answer the following questions
    a. What is the running time of the shell sort in the worst-case scenario? Use Big-Oh notation.

    b. Graphically show the steps of sorting the following dataset by using the shell sort algorithm until gap is 01.

17	26	93	44	77	31	54	55	20

Question 02

01. Give a brief description about the unique properties of following tree structures.
    a. Strictly Binary Tree
    b. Completely Balanced Tree
    c. Binary Search Tree

02. Answer the following question about internal sorting algorithms
    a. Using merge sort as an example, explain how divide and conquer paradigm works.

    b. Use the divide and conquer method to find the maximum number of the following sequence. Show all steps.
       8, 3, 10, 4, 6, 2

    c. Given the following array [10, 5, 3, 9, 22, 24, 28, 27, ?]
       Assuming that Quicksort will be used to sort this array in ascending order, select the value for the last element of the array (indicated by "?") that will make the partitioning most balanced.
       "Partitioning most balanced" means dividing the array into two parts of nearly equal size, one with smaller elements and one with larger elements.
       Option 01: ? = 15 **Option 02: ? = 28**
       Explain why this makes Quicksort perform efficiently.

    d. Show the results of the Quicksort algorithms based on the number you have chosen.

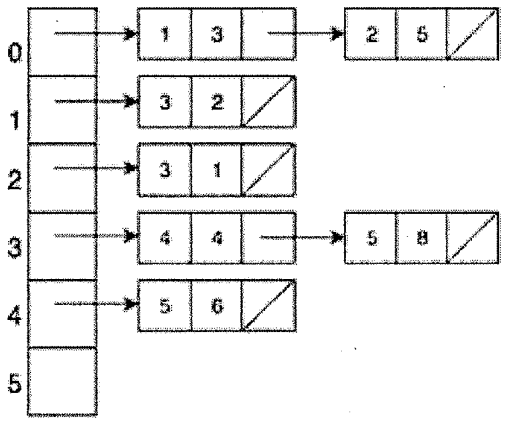
Question 03

01. Write a short description of each of the following types of internal sorting algorithms and provide relevant example algorithms for each category.
    a. Internal sorting by exchange
    b. Internal sorting by insertion
    c. Internal sorting by selection

02. A university intends to store student identification numbers in a hash table to efficient access during online attendance checking.Each student has a unique **4-digit ID number**.
    The system employs a hash table of size **10**, and the hash function is defined as:
    h(ID) = ID mod 10
    The following student IDs are to be stored: **1023, 1054, 1095, 1112, 1134, 1254**

a. Insert each student ID into the hash table using the given hash function. If a collision occurs, resolve it using **rehashing**.
b. Explain how the system would search for a specific student ID (e.g., 1112) within the hash table.

03. The adjacent list of a weighted directed graph is given below.



a. Draw the weighted, directed graph that corresponds to the above given adjacency list.
b. For each vertex, state its indegree and outdegree.
c. With justification, state whether the graph you have drawn is a complete graph.

04. Explain how a queue can be constructed using two stacks? Clearly define the operations enqueue(queue) and dequeue(queue) in terms of the available stack using the operations push(stack) and pop(stack).
Provide suitable pseudocode for each operation. (state any assumptions made).

Question 04

01. If **f (n) = O (g (n))** and **g (n) = O (h (n))**, what can be inferred about the relationship between **f (n)** and **h (n)**?
Name the property of Big-Oh notation that is applied in this case.

02. Answer the following questions with reference to an ArrayList.
    a. Identify two key features of an ArrayList

    b. When the underlying array of an ArrayList becomes full, describe how resizing is performed? Explain the resizing process with the aid of a diagram or algorithm.

03. Consider the following set of symbols to be inserted into a Binary Search Tree(BST). Assume that a key can appear at most twice, and the value of the second encounter of the same key is treated as smaller than the first encounter. Any third occurrence of the same key must be discarded. Construct the BST by inserting the given symbols in the specified order.
    Values to be inserted: + " / ; [& [: + # @ $ * +
    Value Order: ~ ! @ # $ % ^ & * ( ) _ + - = { } | [ ] \ : " ; ' < > ? , . /

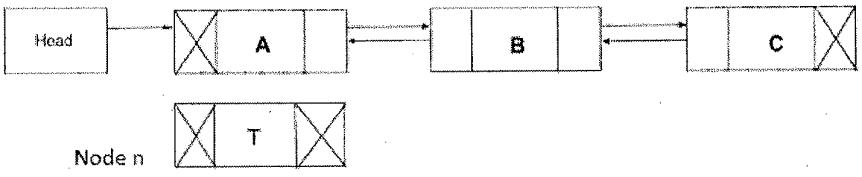
    a. Write down the traversal outputs of the above tree.
        i. Pre-order
        ii. Post-order

    b. State the conditions that must be satisfied for a binary tree to be considered a balanced /AVL tree?

    c. Insert the symbol '<' into the above BST and then perform the necessary operations to convert it into a valid AVL tree. Illustration each step of the transformation process with appropriate diagrams.

Question 05

01. The diagram below represents a doubly linked list.
    a. Write a Java method to insert a new node,pointed by n at the beginning of the doubly linked list.



    b. Write advantages and one disadvantage of a doubly linked list.

02. Answer the following question about external sorting
    a. What is external sorting and why do you need external sorting algorithms?

    b. Sort the below list using the Radix Sort algorithm.
       CAT DOG BAT ANT COW

03. The heap data structure is a type of complete binary tree in which all levels are completely filled except possibly the last level. It follows the heap property.
    a. Name two types of heap structures and briefly describe the property that each type satisfies.

    b. Show the state of the heap after each insertion step.

10	20	15	30	40

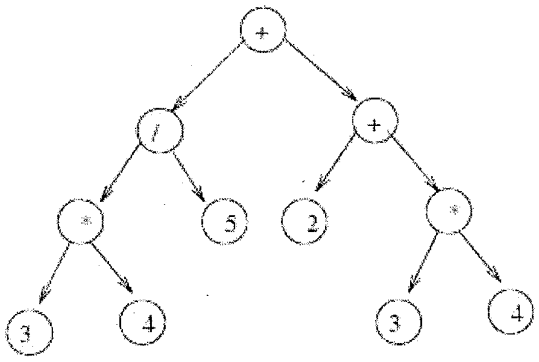
Question 06

01. State the steps for deleting a node in a Binary Search Tree for each of the following cases.
    a. The node to be deleted has **no children** (leaf node).
    b. The node to be deleted has **one child**.
    c. The node to be deleted has **two children**.

02. Answer the following questions.
    a. Both Queue and Stack can be considered as restricted variations of a LinkedList. Discuss this statement.

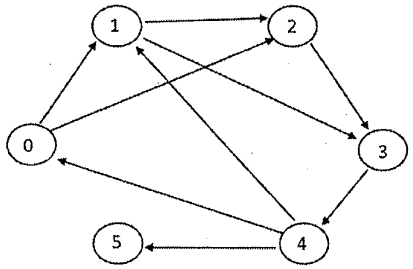
    b. Give the differences between the following pair of operations.
       i. Enqueue and Push operations

03. Consider the following arithmetic expression and its binary tree representation.
    2 + 3 * 4 + (3 * 4) / 5



a. Write the prefix form of the expression
b. Write the postfix form of the expression

04. For the following graph, use vertex 0 as the starting node and determine the order in which the vertices are visited for each of the following graph traversal algorithms
    a. Depth First Traversal
    b. Breadth First Traversal



05. An event management company has a system to organize multiple events every day. Each day is divided into time slots, and for each time slot, there can be multiple events scheduled. The system should allow adding new events dynamically and must process events in the correct order of time.
    a. Suggest a suitable data structure to implement this system.

    b. Explain why this data structure is appropriate for storing and processing events efficiently.