The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Software Engineering Honours
Name of the Examination	: Final Examination
Course Code and Title	**: EEX4465 – Data Structures and Algorithms**
Academic Year	: 2024/2025
Date	: 10th August 2025
Time	: 09:30-12:30
Duration	: **3 hours**

General Instructions

- Read all the instructions carefully before answering the questions.
- This question paper consists of **seven (7)** questions in **five (5)** pages.
- Answer any **Five (5)** questions only. All questions carry equal marks.
- Answer for each question should commence from a new page.
- This is a Closed Book Test **(CBT).**
- Answers should be in clear handwriting.
- Do not use any colour pen other than **blue/black**.
- **General Examination Guidelines of the OUSL are applicable**.

Q1 (20 Marks)

(a) Briefly explain why the Time complexity and Space Complexity is significant in algorithms. [02 marks]

(b) A quadratic algorithm with processing time $T(n) = cn^2$ spends $T(N)$ seconds for processing N data items. How much time will be spent for processing $n = 5000$ data items, assuming that $N = 100$ and $T(N) = 1ms$? [10 marks]

(c) State the time complexity for the following:

a.
int a = 0;
for (i = 0; i < N; i++) {
  for (j = N; j > i; j--) {
  a = a + i + j;
  }
}
	b.
	int i, j, k = 0;
	for (i = n / 2; i <= n; i++) {
	  for (j = 2; j <= n; j = j * 2) {
	  k = k + n / 2;
	  }
	}

c.
int a = 0, i = N;
while (i > 0) {
  a += i;
  i /= 2;
}
	d.
	int a = 0, b = 0;
	for (i = 0; i < N; i++) {
	  a = a + Math.random();
	}
	for (j = 0; j < M; j++) {
	  b = b + Math.random();
	}

[02 X 4 = 08 marks]

Q2 (20 Marks)

(a) Give one advantage and one disadvantage of the linear probing technique. [02 marks]

(b) Insert 12, 13, 22, 23, 32, 33 into the open addressing hash table. The primary hash function is h(k) = k%10. In the case of collisions, use quadratic probing for collision resolution. If an item cannot be inserted into the table, indicate this and continue inserting the remaining values. Do not resize the hash table. Clearly state all your intermediate steps.

[09 marks]

(c) Insert 14,23,2,19,20,5 into a hash table, with the primary hash function h(k) = k%6. In the case of collisions, use separate chaining. If an item cannot be inserted into the table, indicate this and continue inserting the remaining values. Do not resize the hash table. Clearly state all your intermediate steps.

[09 marks]

Q3 (20 Marks)

Given the head of a singly linked list, write a pseudocode algorithm to determine the middle node of the list.

A singly linked list is a data structure where each element (node) contains a value and a reference to the next node. The middle node is defined as:

- The central node in the list if the number of nodes is odd
- The first of the two middle nodes if the number of nodes is even.

Input:

The head of a singly linked list

Output:

The value of the middle node

Example:

- Input: 1 → 2 → 3 → 4 → 5 → Output: 3
- Input: 10 → 20 → 30 → 40 → Output: 20

a. Write a pseudocode function that returns the **value** of the middle node in the linked list. [10 marks]

A web browser keeps track of the pages you visit using a stack. Every time you visit a new page, it is added to the top of the stack. When you press the "Back" button, the most recently visited page is removed.

- VisitPage(page) – adds a new page to the top of the stack
- Back() – removes and returns the most recently visited page
- CurrentPage() – returns the current page without removing it
- IsHistoryEmpty() – checks if the history is empty

b. Write a pseudocode to implement the above operations for this browser history system.

[10 marks]

Q4 (20 Marks)

(a) Write pseudocode algorithms for the operations below in a Binary Search Tree (BST):

i. To delete a node from a BST using a recursive function. [4 marks]

ii. To search for a given value in a constructed BST using a recursive function. [4 marks]

(b) Consider the sequence of numbers given below.

{50, 30, 20, 40, 70, 60, 80}

i. Construct the BST for the above sequence by taking the first element as the root. [4 marks]

ii. Obtain the pre-order traversal of the BST drawn in part i. Clearly state all your intermediate steps. [4 marks]

iii. Re-draw the BST after inserting the new element 25 to the tree drawn in part i. [4 marks]

Q5 (20 Marks)

Given a computer network represented as a graph G, where each device is a node and each direct connection between devices is an edge, develop a plan to explore all devices in the network. Use the Depth-First Search (DFS) algorithm to ensure all devices are visited starting from a selected device S.

Input: A graph G represented as an adjacency list and a starting node S.
Output: The order in which devices are visited.

(a) Write pseudocode for the DFS algorithm that
   a. Starts from a given device *s*
   b. Uses a visited list or set
   c. Recursively explores all directly connected unvisited devices
   d. Prints each device when it is visited

[03 X 4 = 12 marks]

(b) Write the in-order traversal sequence for the tree shown in Figure 1. You need to show all the intermediate steps.

[8 marks]

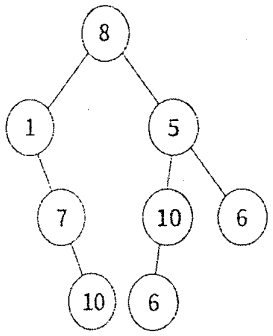

Figure 1: In-order traversal

Q6 (20 Marks)

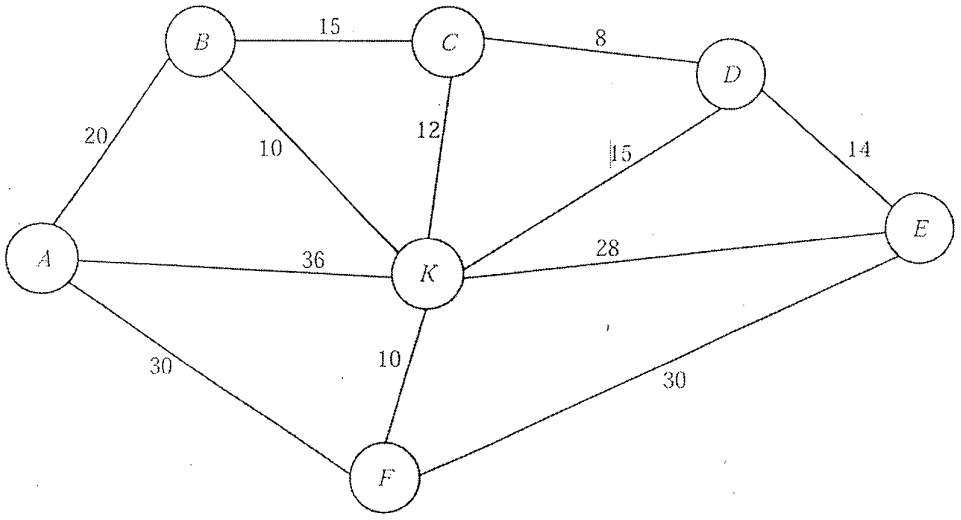

Figure 2: Number of satellite towns and city

Figure 2 shows a number of satellite towns A, B, C, D, E and F surrounding the city K. The number on each edge gives the length of the road in km.

(a) Use Dijkstra's algorithm to find the shortest route from A to E in the network. State your shortest route and its length. [6 marks]

(b) Explain how you determined the shortest route. Describe each step of Dijkstra's algorithm as you applied it to this problem [14 marks]

Q7 (20 Marks)

Merge sort follows the rule of Divide and Conquer to sort a given set of numbers/elements recursively. Answer the following:

a. Briefly describe the rule of Divide and Conquer. [4 marks]

b. Write the pseudocode algorithm for the Merge sort. [8 marks]

c. Use the Merge sort algorithm to sort the below given sequence of numbers. Show the complete step-by-step procedure: [8 marks]

{12, 4, 7, 9, 2, 6}

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