UNIVERSITY OF MORATUWA
Faculty of Information Technology

B.Sc. Honours in Information Technology
B.Sc. Honours in Information Technology & Management
Level 2 – Semester 2 Examination
IN 2110 – DATA STRUCTURES AND ALGORITHMS

Time Allowed: 3 hours | May 2023

INSTRUCTIONS TO CANDIDATES

1. This paper contains four (4) questions on six (6) Pages including the cover page.
2. The total marks obtainable for this examination is 100. The marks assigned for each question are included in square brackets.
3. This examination accounts for 60% of the module assessment.
4. This is a closed book examination.
5. Start answering each question using a new page.
6. Answer **ALL** questions.

ADDITIONAL MATERIAL

None

Continued...

Question 1 - [*Total Marks: 25 marks*]

(a) List two (2) differences between recursion and iteration?

[2 Marks]

(b) Implement the selection sort algorithm using Java.

[4 Marks]

(c) Briefly explain two (2) advantages and one (1) disadvantages of selection sort.

[1×3 Marks]

(d) Using the Selection Sort algorithm, sort the numbers 50, 33, 41, 59, 27, 21, 24, 10. State the steps used in the sorting process.

[4 Marks]

(e) What are the major steps of the Quicksort algorithm?

[2 Marks]

(f) State the ways of choosing a pivot element in the Quicksort algorithm?

[3 Marks]

(g) Using the Quicksort algorithm, sort the numbers 46, 29, 37, 55, 23, 17, 20, 6. State the steps used in the sorting process.

[7 Marks]

Question 2 - [*Total Marks: 25 marks*]

(a) Compare and contrast Stack and Queue data structures.

[4 Marks]

(b) Provide a real-world example in which the queue data structure can be applied.

[3 Marks]

(c) Define each of the following Abstract Data Type (ADT) operations of the queue data structure: *enQueue(x)*, *deQueue()*, *isEmpty()* and *isFull()*.

[2×4 Marks]

Continued....

(d) Consider that you have an integer-typed queue Q and an integer-typed stack S. Graphically describe the statuses of S and Q after each of the following operations:

S.push (4)

S.push (10)

Q.enqueue (6)

Q.enqueue (8)

x = S.pop()

S.push (2)

Q.enqueue(x)

y = Q.dequeue()

S.push(x)

S.push(y)

[1×10 Marks]

Question 3 - [*Total Marks: 25 marks*]

(a) Briefly describe the concepts of static and dynamic memory allocations.

[2 Marks]

(b) Consider the following linked list with four (4) nodes as shown in Figure 1. The first node is the head, and the last node is the tail. Each node has *data* field to store an element, *next* field to point to the next node in the list, and *prev* field to point to the previous node in the list.

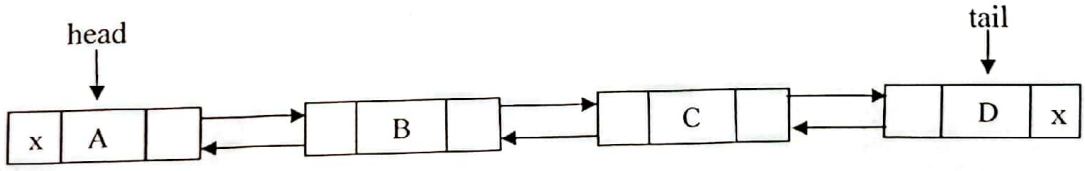

Figure 1: A linked list with four nodes

For each of the code fragments shown below, draw the corresponding Linked list. The list is restored to its initial state before each fragment executed.

i. *head.next.prev = null;*

head = head. next;

ii. *tail.prev.data = head.next.data;*

Continued....

iii. `head.next.next.next.data = tail.prev.prev.prev.data;`

iv. `head.data = head.next.prev.data;`

v. `tail.prev.next = null;`

`tail = tail.prev;`

[2×5 Marks]

(c) Define the following terms.

i) Time complexity

ii) Space complexity

[2×2 Marks]

(d) Find the worst-case time complexity of the following Java code segment in terms of variable n. Explain the steps of the calculation of time complexity.

```
void testFunction(int n){
    for(int i = 0 ; i < n ; i++) {
        for(int j = 0 ; j < 10 ; j++) {
            for(int k = 0 ; k < n ; k++) {
                for(int m = 0 ; m < 20 ; m++) {
                    System.out.println("*");
                }
            }
        }
    }
}
```

[9 Marks]

Continued....

Question 4 - [*Total Marks: 25 marks*]

(a) A Binary Search Tree is constructed by entering the following data set:

40	20	60	10	5	15	50	45	55	70	30	35	75	65	25

i. Draw the binary search tree for the given dataset.

[4 Marks]

ii. Write the order of visited nodes in which the nodes of the above mentioned tree will be visited in *Pre-order*, *In-order* and *Post-order* traversals.

[2×3 Marks]

iii. Draw the two (2) possible binary search trees after deleting the element '40'.

[2×2 Marks]

(b) What is a directed acyclic graph?

[2 Marks]

(c) Write the adjacency matrix for the graph shown in Figure 2.

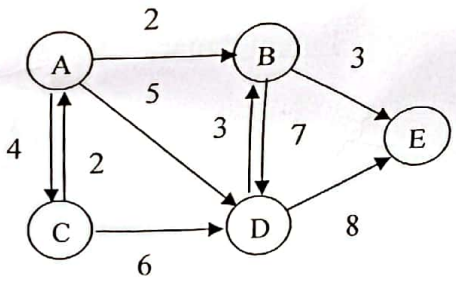

Figure 2: The graph

[4 Marks]

Continued....

(d) Apply the Breadth First Search (BFS) algorithm through the graph shown in Figure 3, starting with Node 0. Write down the order that each node is visited.

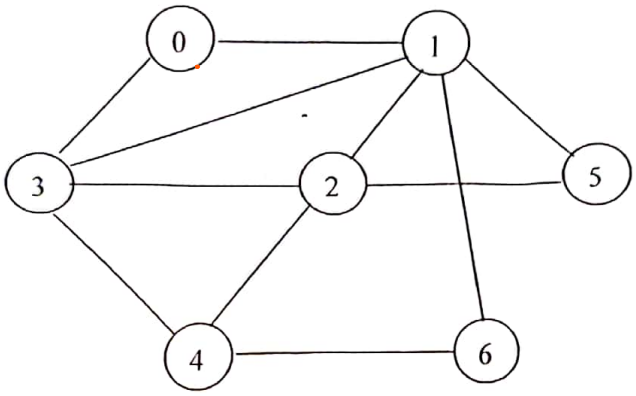

Figure 3: The graph for BFS

[5 Marks]

End of Paper.