Indian Association for the Cultivation of Science

(Deemed to be University under the *de novo* category)

Integrated Bachelor's – Master's program

MID-Semester Examination-2024 (Autumn Semester)

Subject: Data Structures & Algorithms *Subject Code(s): MCS 2101B*

Full marks: 25 *Time allotted: 2 hrs*

Instruction: Answer Q1 and any three questions from the rest.

Best of luck for your exam!

Q1. Answer the following questions with correct explanation. **{5 ×2 Marks}**

i) Is it possible to delete the last node of a doubly linked list in O(1)? Will inclusion of a tail pointer make any difference in terms of worst-case time complexity?

ii) State one difference and one similarity between a LIFO or a FIFO? Provide one example for each.

iii) Why should we use a doubly linked list to implement a deque, instead of a singly linked list?

iv) What will be the worst-case time complexity of an algorithm to input an integer and output its binary equivalent? Write the algorithm and explain.

v) Given, $T(n) = 2^{8log_2 n} + 26n^{124} + 7(log_2 n)^{124}$, what is the worst-case time complexity?

Q2. Define Big-Oh (O), Big-Omega (Ω) and Big-Theta (Θ). Explain the terms with the help of a plot with n (size of the input) in the X-axis and T (time taken) in the Y-axis. **{5 Marks}**

Q3. Write a C program/pseudo-code to implement a stack with a 1-D array of a given length. Make sure that every function inherent to stack is performed in $O(1)$. NB: Assume that the main function exists. Do not use any global variable. {**5 Marks**}

Q4. Write a C function/pseudo-code to insert a node in a non-empty singly linked list located before a node with a key value, which has been provided as an input to the function. NB: Assume that the main function exists, and the nodes have unique values. {**5 Marks**}

Q5. Explain the triple representation of a sparse matrix with an example. What would be the constraints to represent a sparse matrix into its triple representation such that, it would lead to memory efficiency? {**5 Marks**}

Q6. Write a C program or a pseudo-code to implement a queue with a singly linked list. Make sure that every function inherent to queue is performed in $O(1)$. NB: Do not use any global variable. {**5 Marks**}