



Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram
Mid Semester Exam, April 2023

Course Code: CS1004
Batch: CS22 (Batch A and B)
Date of Examination: 29.04.2023
Duration: 1.5 Hours (90 Mins)

Course Title: Data Structures and Algorithms
Category: Core
Instructors: Preeth, Muneeswaran
Maximum Marks: 25

1. You are given pointers pointing to the first node and last node of a singly linked list of size n ($n > 5$), what is the best-case time complexity to search an element that is present in the second position from the last node in the list? Justify. (1 Mark)
2. Using linear search, what is the worst case time complexity to search the first occurrence of the element in the linked list of size n ($n > 5$)? Consider that all the elements are same, and the same element is given as input to search. (1 Mark)
3. Which of the following permutation(s) can be obtained in the output using a stack of size 3? Consider the input sequence in the order as follows 1, 2, 3, 4, 5 (starting from 1). Out of the given below permutations, which is/are the possible valid permutations? Justify your answer. (1 Mark)
(a) 3, 2, 4, 1, 5 (b) 5, 4, 3, 2, 1 (c) 3, 4, 5, 2, 1 (d) 3, 4, 5, 1, 2
4. Arrange the following asymptotic time complexities from faster to slower. $O(n^2)$, $O(1)$, $O(\log_2 n)$, $O(n^3)$, $O(n)$, $O(n \log_2 n)$, $O(\sqrt{n})$ (1 Mark)
5. What is the smallest value of n such that an algorithm whose running time is $100n^2$ runs faster than an algorithm whose running time is 2^n on the same machine. (1 Mark)
6. What is/are the necessary conditions that need to be checked to know whether the circular queue is full? (1 Mark)
7. List out the properties that an algorithm must have. (2 Marks)
8. Sumatra has been given a task by her master. Her task is to perform the operation of concatenation of two linked lists in $O(1)$ time complexity. Whether this can be achieved? If so, for what kind(s) of the linked list, this task is achievable. Justify your answer with a pseudocode. (2 Marks)
9. The following postfix expression is evaluated using stack
 $8 \ 2 \ 3 \wedge / 8 \ 3 \ * + 5 \ 1 \ 4 \ + * /$ What are the two elements (i.e. top and top-1) that are present in the top of the stack once you encounter second $*$. (2 Marks)
10. A single array $A[1 \dots \text{MAX_SIZE}]$ is used to implement two stacks. The two stacks grow from opposite ends of the array. Variables top_1 and top_2 ($top_1 < top_2$) point to the location of the topmost element in each of the stacks. If the space is to be used efficiently, find the condition for "stack full". Explain with an example. (2 Marks)
11. Define theta notation with schematic representation and a suitable example. (2 Marks)
12. Write an algorithm for performing *Insertion Sort* on n numbers. Analyze and Derive the best case, and worst case time complexity by tracing through the steps involved using Step Count method (3 Marks)
13. Two sequences A and B of size n each are available. Both A ($A = \langle A_1, A_2, \dots, A_{n-1}, A_n \rangle$) and B ($B = \langle B_1, B_2, \dots, B_{n-1}, B_n \rangle$) are already stored in two different linear data structures X and Y respectively. The elements of both the sequences are stored in non-contiguous manner. A and $\text{rev}(B)$ are to be added element-wise in order, where $\{A = \langle A_1, A_2, A_3, A_4, \dots, A_{n-1}, A_n \rangle\}$, and $\text{rev}(B) = \langle B_n, B_{n-1}, \dots, B_4, B_3, B_2, B_1 \rangle$, and the resultant should be updated in A in $O(N)$ (i.e. the elements should be traversed only once) time complexity variable each. Identify X and Y and justify your answer. (3 Marks)
14. A stack ADT is implemented using an array, while implementing it is known that the stack is not going to increase above m percentage. The stack can be implemented by using an array as well as a linked list. Analyze the situation and find out the maximum value of m for which the linked list is better than the array for the stack implementation. The stack contains elements of short integer datatype (2 bytes) and each node of the linked list holds the short integer (2 bytes) and an address of the next node (8 bytes). (3 Marks)

All The Best!!!