B2.1-R4: DATA STRUCTURE THROUGH C++

अवधि: 03 घंटे
DURATION: 03 Hours

अधिकतम अंक: 100
MAXIMUM MARKS: 100

ओएमआर शीट सं.:
OMR Sheet No.:

रोल नं.:
Roll No.:

उत्तर-पुस्तिका सं.:
Answer Sheet No.:

परीक्षार्थी का नाम:
Name of Candidate: _____

परीक्षार्थी के हस्ताक्षर:
; Signature of candidate: _____

परीक्षार्थियों के लिए निर्देश: | **Instructions for Candidate:**

कृपया प्रश्न-पुस्तिका, ओएमआर शीट एवं उत्तर-पुस्तिका में दिये गए निर्देशों को ध्यान पूर्वक पढ़ें।	Carefully read the instructions given on Question Paper, OMR Sheet and Answer Sheet.
प्रश्न-पुस्तिका की भाषा अंग्रेजी है। परीक्षार्थी केवल अंग्रेजी भाषा में ही उत्तर दे सकता है।	Question Paper is in English language. Candidate can answer in English language only.
इस मॉड्यूल/पेपर के **दो भाग** है। **भाग एक** में चार प्रश्न और **भाग दो** में पाँच प्रश्न है।	There are **TWO PARTS** in this Module/Paper. **PART ONE** contains **FOUR** questions and **PART TWO** contains **FIVE** questions.
भाग एक "वैकल्पिक" प्रकार का है जिसके कुल अंक 40 है तथा **भाग दो**, "व्यक्तिपरक" प्रकार है और इसके कुल अंक 60 है।	**PART ONE** is Objective type and carries 40 Marks. **PART TWO** is subjective type and carries 60 Marks.
भाग एक के उत्तर, इस प्रश्न-पत्र के साथ दी गई **ओएमआर उत्तर-पुस्तिका** पर, उसमें दिये गए अनुदेशों के अनुसार ही दिये जाने है। **भाग दो** की उत्तर-पुस्तिका में **भाग एक** के उत्तर **नहीं** दिये जाने चाहिए।	**PART ONE** is to be answered in the **OMR ANSWER SHEET** only, supplied with the question paper, as per the instructions contained therein. **PART ONE** is **NOT** to be answered in the answer book for **PART TWO**.
भाग एक के लिए अधिकतम समय सीमा **एक घण्टा** निर्धारित की गई है। **भाग दो** की उत्तर-पुस्तिका, **भाग एक** की उत्तर-पुस्तिका जमा कराने के पश्चात दी जाएगी। तथापि, निर्धारित एक घंटे से पहले **भाग एक** पूरा करने वाले परीक्षार्थी **भाग एक** की उत्तर-पुस्तिका निरीक्षक को सौंपने के तुरंत बाद, **भाग दो** की उत्तर-पुस्तिका ले सकते हैं।	Maximum time allotted for **PART ONE** is **ONE HOUR**. Answer book for **PART TWO** will be supplied at the table when the answer sheet for **PART ONE** is returned. However, candidates who complete **PART ONE** earlier than one hour, can collect the answer book for **PART TWO** immediately after handing over the answer sheet for **PART ONE**.
परीक्षार्थी, उपस्थिति-पत्रिका पर हस्ताक्षर किए बिना एवं अपनी उत्तर-पुस्तिका, निरीक्षक को सौंपे बिना, परीक्षा हाल नहीं छोड़ सकता हैं। ऐसा नही करने पर, परीक्षार्थी को इस मॉड्यूल/पेपर में अयोग्य घोषित कर दिया जाएगा।	**Candidate cannot leave the examination hall/room without signing on the attendance sheet and handing over his Answer sheet to the invigilator. Failing in doing so, will amount to disqualification of Candidate in this Module/Paper.**
प्रश्न-पुस्तिका को खोलने के निर्देश मिलने के पश्चात एवं उत्तर देने से पहले उम्मीदवार यह जाँच कर यह सुनिश्चित कर ले कि प्रश्न-पुस्तिका प्रत्येक दृष्टि से संपूर्ण है।	After receiving the instruction to open the booklet and before answering the questions, the candidate should ensure that the Question booklet is complete in all respect.

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जब तक आपसे कहा न जाए तब तक प्रश्न-पुस्तिका न खोलें।
DO NOT OPEN THE QUESTION BOOKLET UNTIL YOU ARE TOLD TO DO SO.

PART ONE
(Answer all the questions)

1. Each question below gives a multiple choice of answers. Choose the most appropriate one and enter in the "OMR" answer sheet supplied with the question paper, following instructions therein. (1x10)

1.1 The following sequence of operations is performed on stack:
Push (10), Push (20), POP, Push (10), Push (20), POP, POP, POP, PUSH (20), POP
The sequence of values popped out from the stack is
A) 20, 10, 20, 10, 20   B) 20, 20, 10, 10, 10, 20
C) 10, 20, 20, 10, 20   D) 20, 20, 10, 20, 10

1.2 The number of distinct simple graphs with up to three nodes is
A) 15   B) 10
C) 7   D) 9

1.3 The minimum and maximum number of elements in a heap of height 5 are
A) 64, 128   B) 63, 127
C) 64, 127   D) 63, 128

1.4 A binary search tree is generated by inserting the following integers in order:
50, 15, 62, 5, 20, 58, 91, 3, 8, 37, 60, 24
The number of nodes in the left subtree and right subtree of the root, respectively, is
A) (4,7)   B) (7,4)
C) (8,3)   D) (3,8)

1.5 Consider two dimensional array X: array [1..10][1..15] of integer type. Assume that each integer takes one memory location and array is stored in row major order. First element of array is at location 150. What is the address of element X[i,j]?
A) 15j +i +134   B) 15i +j +134
C) 15i +j +184   D) 15j + I +184

1.6 The Postfix representation of the expression (12-X)*(Y+9)/(Z*4) is
A) 4 Y * Z 9 + X 12 -* /   B) / 12 X – Y 9 + Z 4 *
C) 12 – X * Y + 9 / Z * 4   D) 12 X – Y 9 + * Z 4 * /

1.7 Which of the following is not an inherent application of stack?
A) Reversing a string
B) Evaluation of postfix expression
C) Implementation of recursion
D) Job scheduling

1.8 A data structure in which elements can be inserted or deleted at/from both the ends but not in the middle is
A) Queue   B) Circular queue
C) Dequeue   D) Priority queue

1.9 Suppose we have numbers between 1 and 10000 in a binary search tree and want to search for the number 363. Which of the following sequences could not be the sequence of node examined?
A) 2, 252, 401, 398, 330, 344, 397, 363
B) 924, 220, 911, 244, 898, 258, 362, 363
C) 925, 202, 911, 240, 912, 245, 258, 363
D) 2, 399, 387, 219, 266, 382, 381, 278, 363

1.10 Which of the following combinations of traversals can identify binary tree uniquely?
A) Inorder and preorder
B) Preorder and postorder
C) Preorder and levelorder
D) Postorder and levelorder

2. Each statement below is either TRUE or FALSE. Choose the most appropriate one and enter your choice in the "OMR" answer sheet supplied with the question paper, following instructions therein. (1x10)

2.1 Insertion sort gives the best performance, if the input array is sorted or nearly sorted.

2.2 Stack is a first-in-first-out (FIFO) data structure.

2.3 Inorder traversal of heap outputs the keys in ascending order.

2.4 Binary search takes at most n comparisons in successful search when the number of elements in an array is in the range $[2^{n-1}, 2^{n})$.

2.5 A rooted tree is an m-ray tree if every internal vertex has no more than m children.

2.6 Queue is a suitable data structure for recursion implementation.

2.7 The largest sum of possible sum of weights in a connected graph is minimum spanning tree.

2.8 In a k-ray tree of height h, there are at most k^h leaves.

2.9 A Binary tree of height 3 could contain 20 Nodes.

2.10 Multi way merge is an internal sorting method.

ROUGH WORK SPACE:

3. Match words and phrases in column X with the closest related meaning/ word(s)/phrase(s) in column Y. Enter your selection in the "OMR" answer sheet supplied with the question paper, following instructions therein. **(1x10)**

	X		Y
3.1	Not a stable sorting method	**A.**	Dynamic scope
3.2	Deleting elements from front and inserting at rear	**B.**	O(n)
3.3	Linear search	**C.**	User defined types
3.4	Load factor of hash table with m slots and n storage elements	**D.**	m/n
3.5	Depth first search	**E.**	Bubble sort
3.6	Breadth first search	**F.**	Selection sort
3.7	Function which calls itself	**G.**	Back arcs
3.8	Non local variable of a function refers variable of that name	**H.**	Level order
3.9	Structure and union	**I.**	Queues
3.10	Slowest operation(s) when each set is represented as linked list with elements in arbitrary order	**J.**	Recursion
		K.	Iteration
		L.	Union, intersection
		M.	Deque

4. Each statement below has a blank space to fit one of the word(s) or phrase(s) in the list below. Choose the most appropriate option; enter your choice in the "OMR" answer sheet supplied with the question paper, following instructions therein. **(1x10)**

A.	O(n)	**B.**	1	**C.**	2^{h-1}
D.	O(Logn)	**E.**	m/n	**F.**	Topological sorting
G.	4	**H.**	Union	**I.**	abc*+de*f+g*+
J.	n-2	**K.**	T(n)=T(n/2) + constant k	**L.**	Merge
M.	$2^{n(n-1)/2}$				

4.1 The running time for traversing all the nodes of binary search tree with n nodes and printing them in order is _____.

4.2 The number of undirected graphs (not necessarily be connected) out of graph with n vertices is _____.

4.3 The minimum number of stacks of size n required to implement a queue of size n is _____.

4.4 The number of comparisons needed to search a singly linked list of length n for a given element is _____.

4.5 The number of swaps needed in selection sort method is at most _____.

4.6 The minimum number of leaf nodes possible in a complete binary tree of height h >0 is _____.

4.7 Ordering of vertices in a directed acyclic graph based on path information is called _____.

4.8 The recurrence relation that arises in relation with the complexity of binary search is _____.

4.9 Let s be a sorted array of n integers. Let t(n) denote the time taken for the most efficient algorithm to determine if there are two elements with sum less than 1000 in s. Then t(n) is O(_____).

4.10 The postfix expression for (a+b *c) + ((d *e + f) * g) is _____.

ROUGH WORK SPACE:

PART TWO
(Answer any FOUR questions)

5.

a) If n elements are sorted in a binary search tree. What would be the asymptotic complexity to search w key in the tree?

b) What is an algorithm? What are the characteristics of a good algorithm?

c) Consider a binary search tree formed from the keys 10, 5, 7, 13, 8, 12, 3, 4, 9, 2, 6. Assume storing a key value requires 2 bytes of memory and addresses are represented by 4 bytes. What is the amount of memory needed for representing this binary search tree using linked list form?

d) State the advantages and disadvantages of the various collision resolution strategies in hash based methods.

(3+3+5+4)

6.

a) Design a class in C++ that will overload the binary operator + and use it to add the corresponding elements of 2 arrays into a third array.

b) Write a recursive algorithm to compute the value of the recurrence relation

$$T(1) = 1:$$
$$T(n) = T(\lceil n/2 \rceil) + T(\lfloor n/2 \rfloor) + n$$

and then, rewrite your algorithm to simulate the recursive calls with a stack.

c) Write an algorithm to determine whether a directed graph of |V| vertices contains a cycle. Your algorithm should run in O(|V| + |E|) time.

(5+5+5)

7.

a) Write an algorithm to merge two sorted arrays into a third array. Do not sort the third array.

b) A queue is represented in memory using a circular array of size n. Write conditions to check underflow and overflow for this circular array.

c) Write a program to implement extendible hashing. If the table is small enough to fit in main memory, how does its performance compare with open and closed hashing?

(5+5+5)

8.

a) Show the result of inserting 2, 1, 4, 5, 9, 3, 6, 7 into initially empty AVL tree?

b) Show how quick sort processes the input 142, 543, 123, 65, 453, 879, 572, 434, 111, 242, 811, 102.

c) Devise a polynomial time algorithm to decide if two tress T1 and T2 are isomorphic.

(5+5+5)

9.

a) What is a Binary Tree? What is the maximum number of nodes possible in a Binary Tree of depth d. Explain the following terms with respect to Binary tree:
   i)   Strictly Binary Tree
   ii) Complete Binary Tree

b) Prove that in a depth-first spanning forest of a directed graph, all cross edges go from right to left.

c) What is a Binary Search Tree (BST)? Make a BST for the following sequence of numbers.

45, 36, 76, 23, 89, 115, 98, 39, 41, 56, 69, 48.
Traverse the tree in Preorder, Inorder and postorder.

(5+5+5)

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ROUGH WORK SPACE:

ROUGH WORK SPACE: