

## A6-R4: DATA STRUCTURE THROUGH C++

### NOTE:

1. There are **TWO PARTS** in this Module/Paper. **PART ONE** contains **FOUR** questions and **PART TWO** contains **FIVE** questions.
2. **PART ONE** is to be answered in the **TEAR-OFF ANSWER SHEET** only, attached to the question paper, as per the instructions contained therein. **PART ONE** is **NOT** to be answered in the answer book.
3. 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**.

**TOTAL TIME: 3 HOURS**

**TOTAL MARKS: 100**  
(PART ONE – 40; PART TWO – 60)

### 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 “tear-off” answer sheet attached to the question paper, following instructions therein. (1x10)
  - 1.1 Given two sorted list of size ‘ $m$ ’ and ‘ $n$ ’ respectively. The number of comparisons needed in the worst case by the merge sort algorithm will be
    - A)  $m * n$
    - B) maximum of  $m, n$
    - C) minimum of  $m, n$
    - D)  $m + n - 1$
  - 1.2 The postfix equivalent of the prefix  $* + ab - cd$  is
    - A)  $ab + cd - *$
    - B)  $abcd + - *$
    - C)  $ab + cd* -$
    - D)  $ab + - cd*$
  - 1.3 Which of the following statements are true in case of Depth-First-Traversal?
    - i) DFS is used to determine connected components of an undirected graph.
    - ii) DFS is used to determine acyclic nature of a graph.
    - A) only i) is true
    - B) only ii) is true
    - C) both i) & ii) are true
    - D) both i) & ii) are false
  - 1.4 Structure in C++ is a/an
    - A) user defined data type
    - B) ADT
    - C) both A) and B)
    - D) none of the above
  - 1.5 What is the balancing condition of an AVL tree?
    - A) Height factor between +2 and -2
    - B) Height factor between +1 and -1
    - C) Height factor between 0 and -1
    - D) None of the above

- 1.6 The initial configuration of a queue is  $a, b, c, d$  ( $a$  is in the front of queue). To get the configuration  $d, c, b, a$  one needs minimum of
- 2 deletions and 3 additions
  - 3 deletions and 2 additions
  - 3 deletions and 3 additions
  - 3 deletions and 4 additions
- 1.7 A full binary tree with  $n$  leaves contains
- $n$  nodes
  - $\log_2 n$  nodes
  - $2n - 1$  nodes
  - $2^n$  nodes
- 1.8 In linked list, the logical order of elements
- is same as their physical arrangement
  - is not necessarily equivalent to their physical arrangement
  - is determined by their physical arrangement
  - none of the above
- 1.9  $A$  is an array of size  $m * n$ , stored in the row major order. If the address of the first element in the array is  $M$ , the address of the element  $A(i, j)$  ( $A(0, 0)$  is the first element of the array and each element occupies one unit of memory location in memory)
- $M + (i - j)^* m + j - 1$
  - $M + i^* m + j$
  - $M + (j - 1)^* m + i - 1$
  - $M + (i - 1)^* n + j - 1$
- 1.10 Which is not representation of a graph?
- Adjacency matrix
  - Edge list
  - Adjacency list
  - None of the above

2. Each statement below is either TRUE or FALSE. Choose the most appropriate one and ENTER in the “tear-off” sheet attached to the question paper, following instructions therein. (1x10)

- 2.1 The maximum number of nodes in binary tree of depth 5 is 31.
- 2.2 Worst case time complexity of the heap sort algorithm is  $O(n^2)$ .
- 2.3 Complexity expressed in O-notation is upper bound.
- 2.4 The first node of a linked list is pointed by a generic pointer.
- 2.5 Queue is useful in implementing heap sort.
- 2.6 A linear list that allows elements to be added or removed at either end but not in the middle is called stack.
- 2.7 Linked lists are not suitable data structures for radix sort.
- 2.8 The adjacency matrix of an undirected graph is a unit matrix.
- 2.9 BFS scans adjacent unvisited vertex as soon as possible.
- 2.10 A simple undirected graph with eight (8) vertices is said to be complete if number of edges equals to 54.

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 “tear-off” answer sheet attached to the question paper, following instructions therein. (1x10)

X		Y	
3.1	D-queue	A.	Height balanced tree
3.2	Time Complexity	B.	Graph
3.3	Inheritance	C.	Bubble sort
3.4	Minimal Spanning Tree	D.	Stack
3.5	Best case complexity of insertion sort	E.	Double ended queue
3.6	Column major order representation	F.	Preorder traversal of a tree
3.7	Mostly zero entries	G.	Recursion
3.8	Adjacency list	H.	Hashing
3.9	Merge Sort	I.	Worst time is $O(n \log n)$
3.10	DFS	J.	Big-Oh notation
		K.	Building new class from an existing classes
		L.	$O(n)$
		M.	$O(n^2)$
		N.	Array
		O.	Stack
		P.	Hashing
		Q.	Prim's algorithm
		R.	Sparse Matrix

4. Each statement below has a blank space to fit one of the word(s) or phrase(s) in the list below. Enter your choice in the “tear-off” answer sheet attached to the question paper, following instructions therein. (1x10)

<b>A.</b>	queue	<b>B.</b>	stack	<b>C.</b>	priority queue
<b>D.</b>	linked list	<b>E.</b>	polynomial	<b>F.</b>	generic pointer
<b>G.</b>	constant pointer	<b>H.</b>	void pointer	<b>I.</b>	graph
<b>J.</b>	time complexity	<b>K.</b>	space complexity	<b>L.</b>	open addressing
<b>M.</b>	hashing	<b>N.</b>	tree	<b>O.</b>	binary search tree
<b>P.</b>	B tree	<b>Q.</b>	AVL tree	<b>R.</b>	$O(n^2)$
<b>S.</b>	$O(n \log n)$	<b>T.</b>	$O(n)$	<b>U.</b>	Kruskal's Algorithm
<b>V.</b>	Dijkstra's Algorithm	<b>W.</b>	bfs	<b>X.</b>	dfs

- 4.1 The \_\_\_\_\_ of an algorithm is the amount of time the computer requires to execute the algorithm.
- 4.2 Best case complexity of bubble sort is \_\_\_\_\_.
- 4.3 \_\_\_\_\_ is called a FIFO data structure.
- 4.4 \_\_\_\_\_ is a data structure where data can be represented as a chain of nodes.
- 4.5 Recursive functions are internally evaluated by using \_\_\_\_\_.
- 4.6 The declaration `int const *p = &a` signifies *p* as a \_\_\_\_\_.
- 4.7 \_\_\_\_\_ is a mathematical tool used to represent a physical problem.
- 4.8 \_\_\_\_\_ is also known as the balanced order-*n* multiway search tree.
- 4.9 \_\_\_\_\_ is an algorithm in graph theory that finds the shortest path.
- 4.10 \_\_\_\_\_ is a general collision resolution scheme for a hash table.

**PART TWO**  
(Answer any **FOUR** questions)

- 5.
- a) Create a class 'shape' and derive the classes, box, cube, cylinder from it. The class 'shape' has functions volume() and whole-surface-area(). Override these two functions in each of these derived classes. The dimensions of the shapes (box, cube, cylinder) are to be taken from user. Write a main function to test the classes.
- b) Show that the function  $f(n)$  defined by
- $$f(1) = 1$$
- $$f(n) = f(n-1) + 1/n \quad \text{for } n > 1$$
- has the complexity  $O(\log n)$ .

**(9+6)**

- 6.
- a) Consider an array of size  $25 \times 4$ . Base address of this array is 200 and the word size is 4 units. The array is stored in row major form. Find the address of location A (12,3). Also find the address of the same element assuming that the array is stored in column major order.
- b) Consider the following infix expression:
- $$A + B * (C + D) / F + D * E$$
- Convert the above expression in postfix form using stack.
- c) Write an algorithm to delete the last element from a single linked list.

**(6+6+3)**

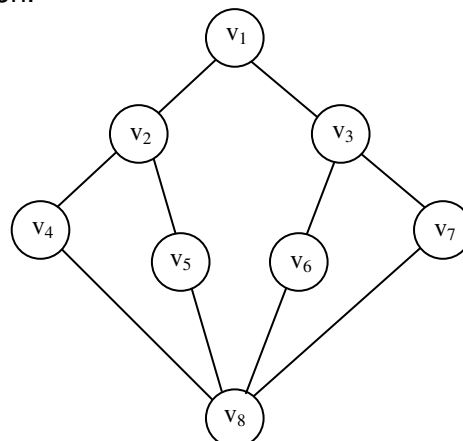
- 7.
- a) The following keys are to be inserted in the order shown below into an AVL Tree: 25,45,50,55,60,65,75,85. Show how the tree appears after each insertion.
- b) The following keys are to be inserted in the order shown below into an B-tree (of order 5): a, g, f, b, k, d, h, m, j, e, s, i, r, x. Show how the tree appears after each insertion.

**(8+7)**

- 8.
- a) What is heap?
- b) Explain with an example how to construct a heap.
- c) Write an algorithm for heap sort. Also find the complexity of the algorithm.

**(2+5+8)**

- 9.
- a) Explain with a suitable example, Prim's algorithm to find the minimal spanning tree.
- b) What is an ADT? For the following graph find out the Breadth First Traversal (BFS). Show the insert and remove operations in/from the Queue ADT during the traversal in a tabular fashion.



**(7+8)**