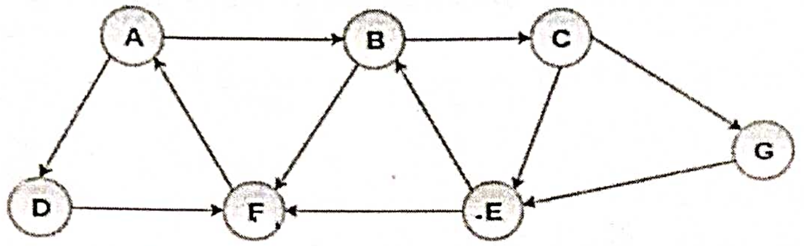
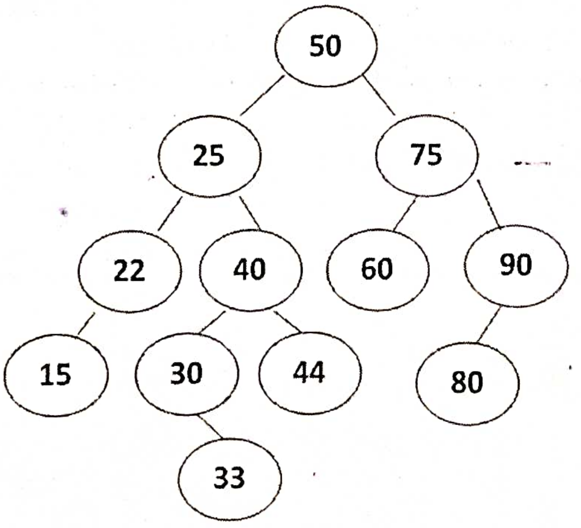
Guru Nanak Dev Engineering College, Ludhiana

Program	B.Tech.(IT)	Semester	3rd
Subject Code	PCIT-101	Subject Title	Data Structures
MSE	MSE-2, Aug-Dec, 2023	Course Coordinator	Er. Parminder Kaur Wadhwa
Max. Marks	24	Time Duration	1 hour 30 minutes

Q. No.	Question	COs, RBT level	Marks
Q.1.	Demonstrate how the depth of a Binary Search Tree effects the average running time *f(n)* to search an item in it (where *n* are the number of items).	CO1, L3	2
Q.2.	Appraise the efficiency of *open-hashing* as a technique to resolve collision.	CO2, L5	2
Q.3.	Consider the following graph and find the minimum path from Node A to Node E.  A → B → C → F	CO3, L3	4
Q.4.	Demonstrate the detailed steps of applying the shell sort algorithm to sort the following unsorted list into ascending order (use *Donald Shell's choice* of increment to create shells):- 66, 25, 40, 57, 33, 48, 37, 20	CO6, L3	4
Q.5.	Consider the following AVL search tree. Construct the balanced trees if the following operations are applied one after the other (not independently). (i) Insert 20 (ii) Insert 14 (iii) Insert 88 (iv) Delete 22 (v) Delete 25 (vi) Delete 75  50 25 75 22 40 60 90 15 30 44 80 33	CO3, L6	4
Q.6.	Suppose the table T (circular) has 15 memory locations. T[1], T[2],...T[15] and suppose the File F consists of 11 records; P, Q, R, A, B, C, V, W, X, D, F with the following hash addresses:- **Records:** P Q R A B C V W X D F **H(k):** 2 5 6 4 5 4 9 11 14 14 15 Suppose the records are entered into the table T in the above order. Evaluate the efficiency of the given hash function with linear probing as the collision resolution technique. Also judge the efficiency if *chaining* method is used and show the memory organization.	CO2, L5 S(α) = 2.35 U(α) - 7.35 U = 3.13 S = 1.72 S(α) = 1.36 U(α) = 1.21	8

U = 1 S = 1.27

Guru Nanak Dev Engineering College, Ludhiana

Department of Information Technology

Program	B.Tech.(IT)	**Semester**	3^{rd}
Subject Code	PCIT-101	**Subject Title**	Data Structures
Mid Semester Exam (MSE) No.	1 Aug-Dec, 2023	**Course Coordinator(s)**	Parminder Kaur Wadhwa
Max. Marks	24	**Time Duration**	1 hour 30 minutes

Note: Attempt all questions

Univ Roll No...

<table>
<tr><th>Q. No.</th><th>Question</th><th>COs, RBT level</th><th>Marks</th></tr>
<tr><td>Q.1.</td><td>Interpret the efficiency of binary search algorithm.</td><td>CO1, L2</td><td>2</td></tr>
<tr><td>Q.2.</td><td>Create the following circular queue :-<table><tr><td>-100</td><td>-2</td><td></td><td>66</td><td>90</td><td>30</td></tr></table></td><td>CO2, L6</td><td>2</td></tr>
<tr><td>Q.3.</td><td>Illustrate the methods to implement priority queue.</td><td>CO2, L3</td><td>4</td></tr>
<tr><td>Q.4.</td><td>Demonstrate the ways of representing a multidimensional array in the memory of the computer system.</td><td>CO3, L3</td><td>4</td></tr>
<tr><td>Q.5.</td><td>Design a recursive algorithm to solve Tower of Hanoi problem.</td><td>CO6, L6</td><td>4</td></tr>
<tr><td>Q.6.</td><td>Design an algorithm to implement the following linked list:-
(i) The node must have "data" part to store information of character data type and "next" part to store the address of the next node.
(ii) Create a pointer variable "HEAD" to store the address of the first node.
(iii) Insert 'J', 'A', 'M', 'E', 'S', 'B', 'O', 'N', 'D' in Linked list (they must occupy nine different nodes).
(iv) Display the content of the linked list to the user.</td><td>CO2, L6</td><td>8</td></tr>
</table>

Course Outcomes (CO) *Students will be able to*

CO1	Analyze and compare algorithms for efficiency using Big-O notation.
CO2	Create and evaluate new algorithms to solve complex engineering problems.
CO3	Illustrate various data structures to solve multi-disciplinary projects.
CO4	Utilize the templates for modularity.
CO5	Compare and classify various data structures
CO6	Demonstrate the reusability of data structures for implementing complex iterative problems

RBT Classification	**Lower Order Thinking Levels (LOTS)**			**Higher Order Thinking Levels (HOTS)**		
RBT Level	L1	L2	L3	L4	L5	L6
RBT Level Name	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating

Guru Nanak Dev Engineering College, Ludhiana

Department of Information Technology

Program	B.Tech.(IT)	Semester	3rd
Subject Code	PCIT-101	Subject Title	Data Structures
Mid Semester Test (MST) No.	MST-I Aug-Dec, 2022	Course Coordinator	Er. Parminder Kaur Wadhwa
Max. Marks	24	Time Duration	1 hour 30 minutes

Student's University Roll No. :- 2121066

Note: Attempt all questions

Q. No.	Question	COs, RBT level	Marks
Q.1.	Demonstrate with example an efficient method of storing a tridiagonal matrix in computer memory.	CO2, L3	2
Q.2.	Specify the situation(s) when operating system performs the garbage collection and mention the steps involved in performing garbage collection.	CO3, L1	2
Q.3.	Analyze and compare the mechanisms to implement priority queue.	CO2, L4	4
Q.4.	Write an algorithm for linked representation of stack and explain its working.	CO3, L6	4
Q.5.	Suppose:- Module A requires X units of time to be executed, where X is a constant. Module B requires Y units of time to be executed, where Y is a constant. Evaluate the order of magnitude of the time complexity function Big Oh which measures the execution time of each of the following algorithms, where n is the size of the input data (denoted by N in the algorithms) :-	CO1, L5	4

P.T.O

(a) **Procedure P1:-**

```
1. FOR LOOP I = 1  TO  N
2.      FOR LOOP  J = 1  TO  N
3.           FOR LOOP  K = 1  TO  N
4.                MODULE A
             [END of Step 3 Loop]
        [END of Step 2 Loop]
   [END of Step 1 Loop]
5. SET  C =1
6. FOR LOOP  C = 1  TO  N
7.        MODULE  B
8.        SET  C = C+2;
   [END of Step 6 loop]
9. EXIT
```

(b) **Procedure P2:-**

```
1. SET J = N
2. FOR LOOP  J = N  TO  J > 1
3.        MODULE A
4.        SET J = J/2
   [END of Step 2 Loop]
5. EXIT
```

Struct node * next
int data;
struct node * top

Q.6	Demonstrate the use of stack data structure in the implementation of recursive algorithm to solve Tower of Hanoi Problem.	CO6, L3	8

Course Outcomes (CO)
Students will be able to

CO1	Analyze and compare algorithms for efficiency using Big-O notation.
CO2	Create and evaluate new algorithms to solve complex engineering problems.
CO3	Illustrate various data structures to solve multi-disciplinary projects.
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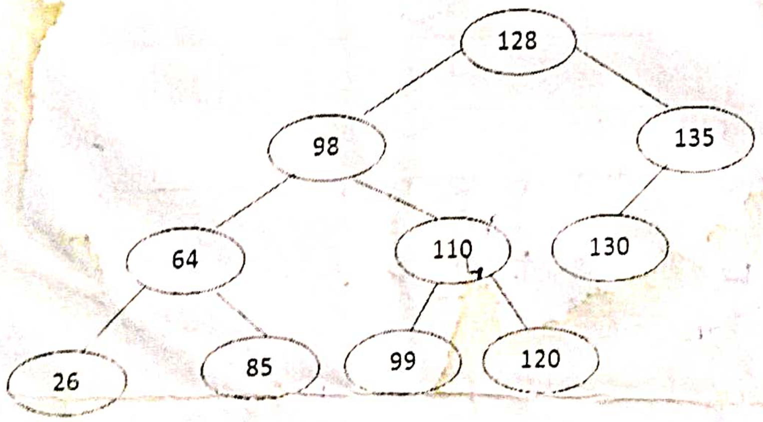
Guru Nanak Dev Engineering College, Ludhiana

Department of Information Technology

Program	B.Tech.(IT)	**Semester**	3rd
Subject Code	PCIT-101	**Subject Title**	Data Structures
Mid Semester Test (MST) No.	MST-2 Aug-Dec, 2022	**Course Coordinator**	Er. Parminder Kaur Wadhwa
Max. Marks	24	**Time Duration**	1 hour 30 minutes
Date	14th November, 2022	**Student's University Roll No. :-**	

Note: Attempt all questions. All assumptions must be clearly stated.

Q. No.	**Question**	**COs, RBT level**	**Marks**
Q.1.	Apply two-way threading with header node in a tree.	CO3, L3	2
Q.2.	Analyze the features that make a graph as a *multigraph.*	CO3, L4	2
Q.3.	Illustrate that a B-tree makes an m-way search tree as balanced tree by maintaining a height close to $\log_m(n+1)$.	CO2, L3	4
Q.4	Demonstrate the detailed steps of applying the recursive quicksort algorithm to sort the following unsorted list into ascending order:- 25, 57, 48, 37, 12, 92, 86, 33	CO6, L3	4
Q.5	Consider the following AVL search tree (shown in Fig. 1):-  128 98 135 64 110 130 26 85 99 120 **Fig: 1** Construct the modified AVL trees while performing the following operations in it (in the same order as mentioned):- (i) Delete 120 (ii) Delete 64 (iii) Delete 130 (iv) insert 102	CO3, L6	4

P. T. O.

Q.6	Suppose the table T (circular) has 11 memory locations. T[1], T[2],...T[11] and suppose the File F consists of 9 records; P, Q, R, A, B, C, V, W, X with the following hash addresses:- **Records:** P Q R A B C V W X **H(k):** 5 4 5 6 8 11 11 1 4 Suppose the records are entered into the table T in the above order. (a) Examine the efficiency of the given hash function with linear probing as the collision resolution technique. *[4 marks]* (b) Formulate the memory organization if the records are stored using *chaining.* *[4 marks]*	CO2, L4, L6	8

Course Outcomes (CO) *Students will be able to*

CO1	Analyze and compare algorithms for efficiency using Big-O notation.
CO2	Create and evaluate new algorithms to solve complex engineering problems.
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RBT Classification	**Lower Order Thinking Levels (LOTS)**			**Higher Order Thinking Levels (HOTS)**		
RBT Level Number	L1	L2	L3	L4	L5	L6
RBT Level Name	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating

V W Q P R A B X C

1 2 3 4 5 6 7 8 9 10 11

V W Q P R A B . C

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8

Please check that this question paper contains 09 questions and two printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. ....

Program: B.Tech. (Batch 2018 onward)

Semester: 3rd

Name of Subject: Data Structures

Subject Code: PCIT-101

Paper ID: .. 16040

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory.
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice.
3) Any missing data may be assumed appropriately.

Part – A

[Marks: 02 each]

Q1.

a) What do you know about Big Oh Notation?

b) Why is circular queue better than linear queue?

c) What is adjacency list?

d) What do you know about skip list?

e) Why balancing is important in Binary Search Tree (BST)?

f) How rehashing is done?

P.T.O

Please check that this question paper contains______ questions and______ printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: ......]

Uni. Roll No. ....

Program: Btech IT

Semester: 3rd

Name of Subject: Object Oriented Programming Using C++

Subject Code: PCIT- 102

Paper ID: 16041

Time Allowed: 02 Hours **Max. Marks: 60**

23-07-21(E)

NOTE:

1) Each question is of 10 marks.
2) Attempt any six questions out of nine
3) Any missing data may be assumed appropriately

Q1. Write a c++ program to print the following pattern using for loop:

```
* * *
*  *
*
```

Q2. Differentiate C and C++ with the help of examples.

Q3. Write a C++ program to display Fibonacci series using do while loop.

Q4. Illustrate the significance of scope resolution operator in C++ with the help of appropriate examples.

Q5. Elaborate the concept of pass by value and pass by reference with the help of example

Q6. Write C++ program to show the concept of multilevel inheritance.

Q7. Explain the concept of run time polymorphism with the help of an example.

Q8. Discuss the use of try, throw andcatch keywords in C++.

Q9. Write a C++ program to show the implementation of ifstream and ofstream classes.

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[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. ....

Program: B.Tech. (Batch 2018 onward)
Semester: 3rd
Name of Subject: Data Structures
Subject Code: PCIT-101
Paper ID: 16040
Scientific calculator is Allowed

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice.
3) Any missing data may be assumed appropriately

Part – A

[Marks: 02 each]

Q. 1

a) State the significance of maintaining AVAIL list and the process used by operating system to perform garbage collection.

b) Illustrate the efficient way of storing sparse matrices in memory.

c) Describe quadratic probing as a technique to resolve collision(s) in hashing.

d) Illustrate the use of adjacency matrix and adjacency list to represent a graph in memory.

e) Evaluate the order of magnitude of the time complexity function Big Oh of the following algorithms, where n is the size of input data:-

(i) Algorithm A:

```
1.   for (i = 1;  i ≤ n; i++)
2.       for (j = 1; j ≤ n, j++)
3.           Module X
4.       end of Step 2 loop
5.   end of step 1 loop
```

$\to$ $0 \to n$

$\to 0 - n$

$O(n^2)$

(ii) Algorithm B:

```
1. for (k = n; k > 1; k = k/2)
2.         Module Y
3. end of step 1 loop
```

$0 \to \frac{n}{2}$

$O(\log n)$

f) Compare Breadth First Search (BFS) and Depth First Search (DFS) graph traversal techniques.

P.T.O.

Part – B

[Marks: 04 each]

Q.2 Explain the ways by which an unbalanced Binary Search Tree (BST) can be made as an AVL Tree (i.e. a balanced tree).

Q.3 Apply Heapsort Algorithm on the following data to sort it in ascending order:-

81, 89, 9, 11, 14, 76, 54, 22

Q.4 Illustrate the operations of insertion and deletion of nodes in a linked list.

Q.5 Design a recursive algorithm to solve Tower of Hanoi problem.

Q.6 Analyze and compare the mechanisms to implement priority queue.

Q.7 Defend the statement that a B-tree makes an m-way search tree as a balanced tree by maintaining a height close to $\log_m(n+1)$.

Part – C

[Marks: 12 each]

Q.8 Describe the implementation of circular queue (using array) and explain how it overcomes the limitations of a linear queue.

OR

*Elaborate the algorithm to implement stack using linked list.

Q.9 Suppose the table T (circular) has 11 memory locations. T[1], T[2],…T[11] and suppose the File F consists of 9 records; P, Q, R, A, B, C, V, W, X with the following hash addresses:-

Records:	P	Q	R	A	B	C	V	W	X
H(k):	5	4	5	6	8	11	11	1	4

Suppose the records are entered into the table T in the above order. Examine the efficiency of the given hash function with linear probing as the collision resolution technique.

OR

*Defend the statement that a Threaded Binary Tree enhances the speed of tree traversal techniques.

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[Total No. of Questions: 09]. [Total No. of Pages: ......]

Uni. Roll No. ....

Program: B.Tech
Semester: 3rd
Name of Subject: Data Structures
Subject Code: PCIT-101
Paper ID: 16040

15-07-21(E)

Time Allowed: 02 Hours **Max. Marks: 60**

NOTE:

1) Each question is of 10 marks.
2) Attempt any six questions out of nine
3) Any missing data may be assumed appropriately

Q1. Construct Min Heap from the following list of numbers by inserting elements one after another.
46 7 86 4 25 17 62 59 33 4.
Show heap after each iteration.

Q2. For a binary search tree T, its in-order and post-order traversals are as follows:

In-order	D	C	K	E	A	H	B	Q	J	I
Post-order	D	K	E	C	H	Q	J	I	B	A

Q3. Design an algorithm to perform insertion and deletion in a Dequeue .

Q4. Apply Bubble sort on the following data and show the contents of the array after every pass:
48 7 26 4 13 23 98 57 10 5 32

Q5. Convert the given Infix expression to Postfix expression using Stack and show the details of Stack at each step of conversion.
Expression : A + ((B - C) / D) * F / G - H

Q6. (a) Insert the keys 76 , 26, 37, 59. 21, 65, 88 into a hash table of size m=11 using double hashing. Further , consider that the auxillary hash functions are h1(k)= k mod

P.T.O.

11 and h2(k) = k mod 9.

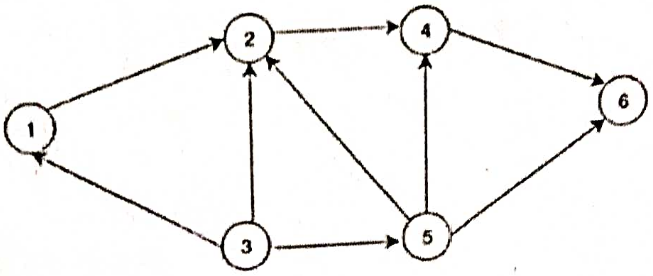
(b) Differentiate between linear and non linear data structure.

Q7. Explain in detail different ways of storing multidimensional arrays in memory?

Q8. (a) Design an algorithm to delete an element from a circular linked list.

(b) Design an algorithm to insert an element in a sorted doubly linked list.

Q9. Find the adjacency matrix and adjacency list for the graphs give below:



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Please check that this question paper contains 09 questions and two printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. ....

Program: B.Tech. (Batch 2018 onward)

Semester: 3rd

Name of Subject: Data Structures

Subject Code: PCIT-101

Paper ID: 16040

Max. Marks: 60

Time Allowed: 03 Hours

NOTE:

1) Parts A and B are compulsory.

2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice.

3) Any missing data may be assumed appropriately.

Part – A

[Marks: 02 each]

Q1.

a) What do you know about Big Oh Notation?

b) Why is circular queue better than linear queue?

c) What is adjacency list?

d) What do you know about skip list?

e) Why balancing is important in Binary Search Tree (BST)?

f) How rehashing is done?

P.T.O

Part – B **[Marks: 04 each]**

Q2. Explain how insertion and deletion is implemented in doubly linked list.

Q3. Write a brief note on B-trees.

Q4. How recursion is used in Tower of Hanoi problem?

Q5. What is need of hashing? Discuss the various hash functions.

Q6. Discuss Garbage Collection and Compaction.

Q7. Draw a graph and differentiate between Breadth First Search and Depth First Search in it.

Part – C **[Marks: 12 each]**

Q8. Convert the infix expression A+(B*C-(D/E^F)*G)*H to postfix notation using stack.

OR

Differentiate between the input-restricted and output-restricted deque (double ended queue) and elaborate the applications of deque in detail.

Q9. Explain the Merge Sort in detail by sorting the following list and discuss its complexity:-

{14, 33, 27, 10, 35, 19, 42, 44}

OR

* Perform the comparative study of the time complexity of a skewed Binary Search Tree (BST) and AVL trees.

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[Total No. of Questions: 09] [Total No. of Pages:1]

Uni. Roll No. ....

Program/ Course: B.Tech. (Sem.3)
Name of Subject: Data Structures
Subject Code: PCIT-101
Paper ID: 1131

EVENING
3 0 NOV 2019

Time Allowed: 3 Hours **Max. Marks: 60**

NOTE:

1) **Parts A** and B are **compulsory**
2) **Part-C** has two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

Q1.

a) List the areas of applications of data structures.

b) With the help of code snippet explain complexity analysis.

c) Which data structure is ideal to perform Recursion operation and why?

d) Convert the below given expression to its equivalent Prefix and Postfix notations:
((A + B) * C – (D – E) ^ (F + G))

e) Consider a scenario, where one need to store large amount of data in an array. But, the memory to store that data is not available contiguously. In such scenario what will be your choice and how does your choice differ from arrays?

f) Why it is said that searching a node in a binary search tree is efficient than that of a simple binary tree?

Part – B **[Marks: 04 each]**

Q2. Discuss how circular queue overcomes limitations over linear queue with example.

Q3. Write an algorithm to implement stack using linear array.

Q4. Describe the role of garbage collection and compaction.

Q5. How can one find time complexity of an algorithm? Justify your answer with example(s).

Q6. Design and evaluate a code that demonstrates the insertion operation at the beginning of a doubly linked list

Q7. Design an algorithm to insert and delete elements in binary search tree.

Part – C **[Marks: 12 each]**

Q8. Write a recursive algorithm to solve the problem of Tower of Hanoi.

or

Compare various searching methods in data structures.

Q9. Based on complexity, stability and memory constraints, analyse different sorting techniques.

or

Based on data structure used for nodes, memory, structure of constructed tree, traversing, optimality, application etc., analyse BFS and DFS searching techniques.

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$5x + 9y$
$5x + 9y$

Please check that this question paper contains 9 questions and 2 printed pages within first ten minutes

[Total No. of Pages: 2]

[Total No. of Questions: 09]

Uni. Roll No. 2203751

Program: B.Tech. (Batch 2018 onward)

Semester: 3

Name of Subject: Data Structures

Subject Code: PCIT-101

Paper ID: 16040

Max. Marks: 60

Time Allowed: 03 Hours

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

Q1.

a) List the different types of queues and their key characteristics.

b) List the different representations of graphs.

c) List the basic operations that can be performed on common data structures.

d) Describe the concept of collision resolution in hashing.

e) Differentiate between time complexity and space complexity.

f) Name two operations that can be performed on a doubly linked list.

Part – B **[Marks: 04 each]**

Q2. Develop an algorithm to sort a list of numbers.

Q3. Compare and contrast the sequential and linked representations of trees, highlighting the advantages and disadvantages of each.

Q4. Explain the operations that can be performed on linear and multi-dimensional arrays.

Q5. Devise a method for balancing an AVL tree after a series of insertions and deletions.

Q6. Develop a recursive solution for the Tower of Hanoi problem. Explain the underlying principles of your solution.

Q7. Evaluate the advantages and disadvantages of using a linear queue versus a circular queue.

P.T.O.

Part – C **[Marks: 12 each]**

Q8. Explain the key terminology associated with trees, including concepts like root, leaf, parent, and child nodes.

OR

Explain the concept of Big O notation and its significance in algorithm analysis. Evaluate the trade-offs between time complexity and space complexity in algorithm design.

Q9. Implement the insertion operation for a linear linked list. Compare the advantages and disadvantages of linear linked lists and doubly linked lists. Apply the bubble sort algorithm to sort a given list of numbers.

OR

Evaluate the applications of stacks, specifically in the context of converting infix to prefix and postfix expressions. How does the use of stacks simplify these operations?

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Please check that this question paper contains 09 questions and two printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. ……………

Program: B.Tech. (Batch 2018 onwards)
Semester: 3rd
Name of Subject: Data Structures
Subject Code: PCIT-101
Paper ID: 16040
Scientific calculator is Allowed

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice.
3) Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

Q. 1

a) Define the time complexity of an algorithm.

b) Explain the storage of sparse matrices.

c) Apply two-way threading with a header-node in a tree.

d) Describe the need of hashing.

e) Analyze the features that make a graph as a multigraph.

f) Differentiate between Adjacency Matrix and Adjacency List.

Part – B **[Marks: 04 each]**

Q. 2 Apply Shell Sort algorithm to sort the following data in ascending order:-

54, 26, 93, 17, 77, 31, 44, 55, 20

P.T.O.

Q. 3 Demonstrate the use of stack data structure to convert the following infix expression into postfix expression:-

a + b * c + (d * e + f) * g

Q. 4 Explain the various techniques that can be used to handle the problem of collisions in hashing.

Q. 5 Analyze and compare the mechanisms to implement priority queue.

Q. 6 Defend the statement that a B-tree makes an m-way search tree as a balanced tree by maintaining a height close to $\log_m(n+1)$.

Q. 7 Design an algorithm for implementing stack using linked list and explain its working.

Part – C **[Marks: 12 each]**

Q. 8 Demonstrate the implementation of a recursive algorithm to solve Tower of Hanoi problem involving three disks.

OR

Describe the implementation of doubly-linked list and explain how a node is added and removed from it.

Q. 9 Construct an AVL tree by inserting following numbers in an empty AVL tree:-

50, 20, 60, 10, 8, 15, 32, 46, 11, 48

OR

Compare the graph-traversal-techniques of Breadth First Search (BFS) and Depth First Search (DFS).

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